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The braille production system in the United States is described. Aspects treated are the following: the need for braille (the braille system), the market for braille (size and characteristics), sources of braille (producers and braille book source information), and present methods and costs of producing braille. Technological advances are discussed in terms of the braille system, research, automated braille production concepts, equipment and techniques for automated braille, and production techniques. The effects of innovation on braille production considered are the economics of automated braille production, the market for new devices, the effects on the market for braille, and the sociological effects of innovation. An approach to braille system development is outlined, including the marketing approach, marketing, braille research philosophy, and the future. References are cited for each area, and 70 exhibits are provided. (JD)

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Its Production, Distribution, and Use

Louis Harvey Goldish

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Braille in the United States:

Its Production, Distribution, and Use

Louis Harvey Goldish

Submitted in partial fulfillment of the requirements for the degree of Master of Science at the Massachusetts Institute of Technology, January, 1967.

It is not thy duty to complete the work, but neither art thou free to desist from it.

Ethics of the Fathers (Jewish Talmud)
2:21

There is no lovelier way to thank God for your sight than by giving a helpful hand to someone in the dark.

Helen Keller

This work is dedicated to the many blind who are overcoming their inconvenience and to the many organizations and individuals who are helping them do it.

Foreword

Blindness need not relegate an able person to dependence on aid or to employment in a sheltered workshop. Access to written material, however, is of vital importance if the blind are to succeed in a world so highly geared to graphic communication.

Many people would like to help the blind, specifically in the field of braille production, while others who are already doing so would like to know more about the field. Yet, one often hears the following type of statements:

"Why not just make a machine that prints an 'A' cell every time you hit the 'A' key?"

"We would like to help the blind. Perhaps a ——— would be helpful."

"Oh, there must be millions of braille readers who could use a ———."

"There must be a better way to read than using this stuff."

"That's really great! How much does it cost?"

It is statements such as these that have provided suggestions for the contents of this report.

This report is a first work, the first attempt to describe fully the braille production system in the United States. Some of its content may be questioned. Many of the facts are implied and most of the figures are estimated. This is often the nature of a first work.

This report is not to serve solely as a definitive, hard-fact account of the braille production system. Many details are lacking. Rather, it should serve as the initial work from which detailed studies can be instituted. Also, while this work has purposely been limited to braille in the United States, it should be noted that there is a large world market for braille and associated devices.

If the developer of a device looks at the estimates given here and says,"That can't be right," and makes a more accurate estimate, the goal of this report shall have been fulfilled. If a blind service agency takes issue with one of the market or production statistics and provides more accurate ones, the goal of this report shall have been fulfilled. If reevaluations and resulting improvements are made in some of the new devices mentioned herein because of some of the statements made, the goal of this report shall have been fulfilled.

The goal of this report is that the blind be offered as much opportunity as possible through the efficient, economical production and distribution of brailled material.

Acknowledgment

Much of the data in this report is based on interviews, letters, telephone calls, and materials from helpful, dedicated people in blind service agencies, universities and laboratories, and braillist groups. Space does not allow individual acknowledgment, but heartfelt thanks are extended to each of these people.

The difficult job of preparation of this manuscript was wholly performed by Miss Myler Greene who, often at personal inconvenience, saw to it that almost one thousand pages of hieroglyphics were converted into readable material.

This work was supported by The Vocational Rehabilitation Administration of the United States Department of Health, Education, and Welfare SAV-1044-66 and sponsored by the Division of Sponsored Research of the Massachusetts Institute of Technology under the guidance of Professors Robert W. Mann and Robert C. Casselman and Mr. John K. Dupress. Preparation and publication of the report was underwritten by the American Foundation for the Blind.

Preface

Since 1959 the Sensory Aids Group in the Department of Mechanical Engineering at MIT, with support from the Vocational Rehabilitation Administration, has been conducting research and development on a comprehensive system directed toward increasing the volume, variety, and rapidity with which formal and informal printed literature, correspondence, and notes can be made available to the blind in the form of contracted braille.

Now that major parts of this computer-based, braille-translating system have been demonstrated to be technically feasible and to produce completely acceptable braille, the major thrust of the over-all effort is increasingly concerned with the means by which elements of, and the total system, may be deployed and utilized by organizations for the blind and by the blind themselves. The practical implementation of the system and its devices poses many developmental, economic feasibility, and market demand problems, some common to any profit-oriented commercial effort and some peculiar to current and potential braille reading "customers."

In his Master's thesis in Industrial Management in the Alfred P. Sloan School at MIT, Mr. Louis H. Goldish provides very useful descriptions and data on the potential braille market, current sources of braille, and the new technology in braille production. His discussion of the economics of the new techniques and of the market represent careful, but of course debatable, estimates of probable costs of, and reader responses to, the new capabilities.

While hard-headed estimates of the foreseeable costs of an innovation are an essential element in accommodating to change, decisions to move forward must recognize both this businesslike approach and the concomitant long-range social and economic benefits. Clearly these will accrue to the individual and to society as a result of enhanced stature and vocational promise derived from increased access to the world's store of information. Mr. Goldish's brief, but compelling, illustration of the potential recoup of the investment costs of the proposed system through tax payments from vocationally enabled blind must be balanced against the clearly significant cost of expediting these new capabilities. And beyond these tangible benefits we must not overlook the perhaps more important sense of personal value derived from the independence this system can help to provide.

Robert W. Mann
Professor of Mechanical Engineering
Massachusetts Institute of Technology

Background

The increasing integration of blind school children into classes with sighted children, the growing number of blind adults seeking higher education and employment in the competitive labor market, and the "information explosion" have greatly increased the demand for braille reading material for the blind.

At present braille transcription is primarily a slow, manual process. Standard braille does not have a one-to-one correspondence with English letters, but, rather, consists of numerous contractions and abbreviations, the use of which is governed by a very complex set of rules. Thus a skilled braillist is required for transcribing written material into braille.

While braille publishing houses produce the more widely used multiple copy material, approximately 5,000 volunteer braillists transcribe individual requests. These brailling programs are administered by an assortment of independent federal, state, local, religious, and philanthropic organizations. Increased demand, however, is making it difficult to fill all the requests for braille under the present arrangement.

Consequently, research is being conducted in methods to enhance the production of braille. Computers have been applied to the tasks of translating English into braille, and a number of mechanical and electrical devices such as high-speed braille embossers, electrified braillewriters, and braille on paper-tape units have been developed.

The market for braille in the United States is small—fewer than 45,000 active braille readers, and perhaps not even that many. It is characterized by limited finances and diverse needs, and it is highly affected by personal, political, and emotional factors. Many of the new concepts which have resulted from research are complex and expensive, and their application would require some major changes in the present procedures, organizations, and attitudes which have existed for almost a century. Thus a careful study of this market is necessary to see if such changes can be made and how they can best be accomplished so that efficient economical braille production will result.

The Engineering Projects Laboratory and the Sensory Aids Evaluation and Development Center, both of the Massachusetts Institute of Technology, are presently involved in braille research under grants from the Vocational Rehabilitation Administration of the United States Department of Health, Education, and Welfare. This study is part of that program.

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Chapter 1

The Need for Braille

Because of their handicap, the blind must resort to special methods of reading and writing if they are to take an active part in our society which is so highly geared to graphic communication. Thus the blind have sighted readers read written material to them, they use voice recordings, or they read braille. Because no one method is best for all reading applications, all three are necessary.

Braille is a series of raised dots embossed into paper and read by passing the fingers lightly over the braille lines of the page. The braille characters consist of from one to six dots arranged in a six-position matrix. Because braille does not have a one-to-one correspondence with English letters but, rather, uses a very complex grammar of contractions, abbreviations, and special symbols, extensive instruction and practice is needed before braille can be read with facility. Even then, the average blind high-school senior reads braille at about 90 words per minute as compared with the 250 words per minute of his sighted peers and the 175 words-per-minute speed at which voice recordings are made.[1]

Because of these and other limitations, braille is used primarily for material that requires considerable concentration, that must be read slowly or reread a few times, or where the learning process will benefit more from active reading of the material than from just passively listening to it. Consequently, textbooks used in elementary and secondary education are transcribed into braille. Technical, mathematical, and foreign language material and many difficult college texts are read in braille. Material in braille is more easily skimmed or sampled than recorded material; hence braille is preferred for quick reference applications. Also, braille is the only mode of reading that the deaf-blind can use without the aid of sighted readers. Thus, although other modes of reading are available to the blind, there is a definite need for braille material. Today more blind children are being integrated into sighted classes in public schools, more blind students are attending college, and the number of blind in the professions is increasing. Furthermore, the amount of braille material utilized by these groups has grown considerably. This, in turn, has magnified the difficulties associated with the production and distribution of braille.

THE BRAILLE SYSTEM

To appreciate fully the problems encountered in the production, distribution, and use of braille—and why great efforts are being made to solve them—some familiarity with the braille system may be helpful.

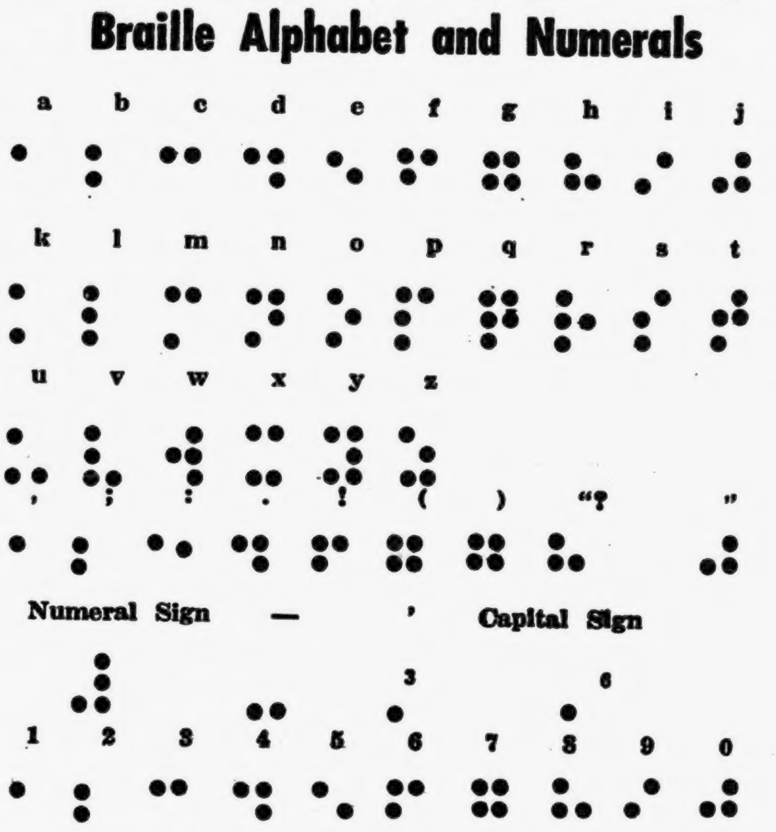
The system of raised-dot printing which enables the blind to read using their sense of touch was first developed by Louis Braille in the nineteenth century. Although other systems have been designed and used for the same purpose, the braille system has been accepted throughout the world as the basis of reading codes for the blind.

The Braille Codes[2]

The basic literary braille alphabet used in the United States is shown in Exhibit 1.1. In actual embossed braille the size and spacing of the dots in the braille cell as well as their height above the page are held to specified standards. Note that there is no relation between the dot configuration and the shape of an inkprint character.

Originally, braille included only characters for each letter of the alphabet, numerals, and punctuation marks. Material was transcribed letter for letter, and this system is known as Grade 1 braille. In the years since its introduction many additions and changes have been made to the braille system, each with a view to simplifying the blind reader's task. As a result, Grade 1 braille is seldom used today.

Most of the present-day braille is Grade 2 braille, a highly contracted system of representation which utilizes all of the 63 possible dot combinations, many of which have multiple meanings. In straight prose this system uses only about 60 percent of the cells needed



The six dots of the Braille cell are arranged and numbered thus: 1 ● ● 4, 2 ● ● 5, 3 ● ● 6. The capital sign, dot 6, placed before a letter, makes it a capital. The numeral sign, dots 3, 4, 5, 6, placed before a character, makes it a figure and not a letter. The apostrophe, dot 3, like the other punctuation marks, is formed in the lower part of the cell.

Exhibit 1.1. The Basic Braille Code

by Grade 1 braille.[3] As a result, bulk is reduced and reading speed is increased by using Grade 2. The present Grade 2 code used in the United States (*English Braille, American Edition, 1959*) utilizes 189 whole words and letter combinations which may be represented in contracted form. Examples of this are given in Exhibit 1.2. Although Grade 2 braille is most commonly used, there actually exists a spectrum of braille codes. The simplest is Grade 1, the letter-for-letter system.

The next is Grade 1½ which utilizes only 44 one-cell contractions.[4] Next is Grade 2 followed by Grade 3, which contains over 500 contracted forms and is used mainly for personal note-taking.[5] The most abbreviated form is braille shorthand which is designed for use by blind stenographers.[6]

In addition to the literary braille codes, there are other codes utilizing the same six-dot embossed braille cell but whose configurations have meanings quite different from those of the literary codes. The *Nemeth Code of Braille Mathematics and Scientific Notation* (1965), which is used for advanced mathematical and technical material, provides for braille representation of the many special symbols found in these subjects. There is a special braille code for musical notation. Also, there are braille codes for many of the more common languages of the world.

Although the embossed dots and the braille code may appear to a sighted reader as a very inefficient, complex means of displaying reading material to the blind, it has been found that the dots, which are uniform in size and shape and arranged in the six-position cell, can be surveyed with a minimum of finger movement and line redundancy. Also, this dot arrangement is much easier to produce and read than methods using raised lines, letter outlines, and similar techniques. Indeed, modern braille has been found to be a very efficient communication system.[7,8]

Systemic Problems in Braille

While the slow reading speed and extensive training period for learning braille limit its appeal, these factors are inherent in any familiar language, not only braille, so that they are accepted as part of the training and usage process. There are, however, certain systemic problems—that is, problems inherent in the present braille production system, which, over and above the unfamiliarity of the braille code, make braille production, distribution, and use either difficult or inconvenient. These include (*1*) transcription complexities, (*2*) production problems, (*3*) distribution problems, (*4*) storage and display problems.

Transcription Complexities

The braille transcription problems arise from the complex rules which govern the use of Grade 2 braille codes. While the shorthand nature of Grade 2 braille facilitates the reading process, it makes the transcription task very difficult.

A contraction may be used to represent only one given letter combination; however, it may not always be used. There are restrictions based on the position in which these letters occur within a word, the pronunciation of the word, and syllabification of the word

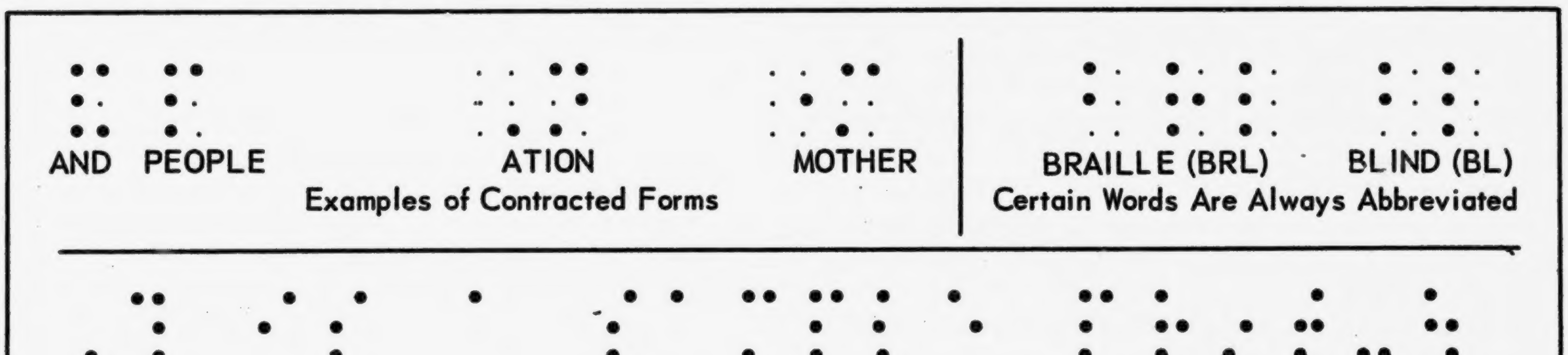


Exhibit 1.2. Samples of Grade 2 Braille

or phrase. Exhibit 1.2 lists a few examples of these complex rules.

In addition to the rules governing translation, there are rigid specifications governing the number of lines per page, the numbering of pages, placement of titles, and other format elements.[9] Because of these complex rules, a highly skilled braillist is required to transcribe printed material into braille. About six months of training under very stringent performance standards are required before a braillist can be certified, and then about two years of experience are needed before she becomes truly adept at literary braille.[10] Braillists who do this work full-time for braille presses are the most expert, and there are many difficulties in hiring, training, and keeping competent, full-time braillists.[11] Specialized codes and foreign languages require even more time and training.

Thus a major problem in implementing the braille system is the recruiting of qualified braillists. The increasing demand for braille has already taxed the braille-producing facilities to the point where aid is necessary both to alleviate the backlog of braille transcription orders and either to aid the braillist in mastering the complex braille rules or to make it possible for less skilled personnel to produce accurate braille.

Production Problems

Almost all braille transcription is done manually. The braillist reads the inkprint copy and then transcribes it into braille using a braille-embossing device. Single-copy embossing on paper is usually done on a braillewriter similar to the one shown in Exhibit 1.4. By pressing the appropriate keys, a braille cell is embossed. Zinc masters which are used for multiple-copy press braille are made on a machine whose operation is very much like that of the braillewriter—manually depressing appropriate keys.

Manual brailling, however, is an extremely slow process. A good braillist completes an average of five braille pages of straight prose per hour. With 100 pages to a volume and five volumes to an average book, a braillist spends an average of 100 hours on each title.[12] The specialized codes and pages requiring embossed line drawings require even more time. A braillist can average only about two braille music pages per hour.[13] Error correction is a tedious, time-consuming process which adds to brailling time. Also, zinc plates, textbook masters, and books to be circulated by the Library of Congress services must be sent to proofreaders to insure accuracy. This adds greatly to production time.

Because of the long time necessary for braille production and the heavy demand for braille, current material is in short supply. Educational textbooks, the choice of which is often made only by late summer but copies of which are usually needed by mid-September, pose great production problems. Current popular titles are not readily available, and personal communications which are often needed in braille immediately upon receipt are almost impossible to obtain easily.

1. The contraction COM may only be used at the beginning of a word . . . but it need not be a syllable. It must never be used in contact with a hyphen, dash, or apostrophe.
2. The contractions for BE, CON, and DIS may be used *only as syllables* at the beginning of a word.
3. The word signs A, AND, FOR, OF, THE, and WITH should follow one another without a space between *if there is no natural pause.*
4. One-cell whole word contractions (CAN, FROM, YOU, etc.) when separated by a space from other letters or contractions will be read as a word. They may be used when followed by the apostrophe in familiar combinations. However, they should not be used in rare or colloquial forms.
5. Final letter contractions (FUL, LESS, etc.) should be used in the middle or at the end of the word. They should never begin a word.
6. A contraction must not be used where the usual Braille form of the base word would be altered by the addition of a prefix or suffix.
7. Contractions forming parts of words should not be used where they would obscure the recognition or pronunciation of a word.

Exhibit 1.3. Some examples of Rules for Grade 2 Braille (Source: Ann S. Schack and R.T. Mertz, *Braille Translation Systems for the IBM 704*, New York: IBM Data Systems Division, 1961.)

Here, then, is an area where help is needed. Some method for rapid production of brailled material is necessary.

Distribution Problems

The sighted reader can usually obtain almost any book he desires either in a local bookstore or from a local library. The blind have a much greater problem.

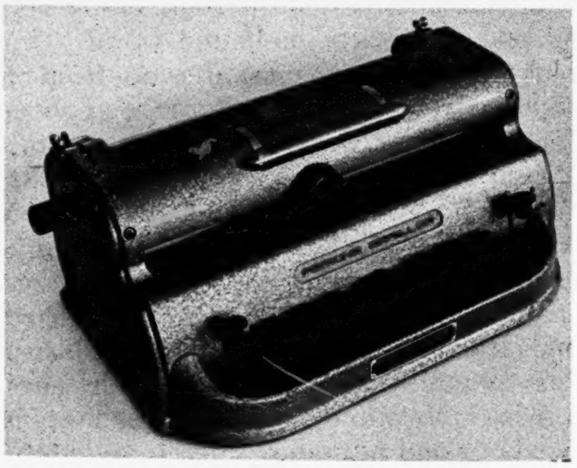


Exhibit 1.4. A Mechanical Braillewriter (Manufacturer: The Howe Press of Perkins School for the Blind.)

Library facilities are limited: the most common are those of the Library of Congress which maintains only 28 braille-library distribution centers throughout the country and stocks only recreational reading material. Few of these libraries have open stacks; selection and distribution is usually done by mail. Books often must be requested from other libraries on an if-and-when available basis.

Book sources are also limited. The major source of individual copy material is from volunteers spread through the country, and more popular material is produced by only four major presses. Although records of most of their output are maintained in a few central coordinating catalogs, these do not insure the existence or the availability of a given title, and it is up to the requester to endeavor to contact the publisher or present owner of the book. Locating and obtaining a book usually requires considerable time and effort and often proves fruitless.

Thus, some method of rapidly determining the availability of a book and easily obtaining a copy is sorely needed.

Storage and Display Problems

Braille books are large and often unwieldy. A single braille volume is approximately eleven inches wide by eleven inches high, averages about three inches in thickness and weighs an average of about three pounds. Some comparisons between inkprint books and their braille equivalent are given in Exhibit 1.5. As shown, a braille library with even a moderate selection of books requires an enormous amount of storage space.

A means of storing books in a compact form would make it much easier to set up and maintain a braille library facility.

Other Aspects

These, then, are the major obstacles to efficient production and distribution of braille material. While many of these arise from the nature of the braille code, it must be remembered that the basic braille system is accepted and used throughout the world. Thus, the solution of these problems must arise not from changes in the braille system as much as from the application of technology and advances in data handling, information retrieval, and computer science to the immediate problems at hand.

One must recognize, however, that the market for braille is small, its finances are limited, its needs are diverse, and its traditions are well established. Yet some innovation in braille production and distribution encompass complex and expensive techniques, and some of these innovations may require changes in existing procedures and attitudes. Therefore, careful consideration by both innovators and braille producers must be given to new approaches if more efficient and economical braille production is to result.

Average Characteristics of a Single Volume

	Braille[a]	**Inkprint** (hardcover)[b]
Size:	11" x 11" x 3"	5½" x 7½" x 1½"
Weight:	3 pounds	1½ pounds (780 pages)

	Inkprint	**Braille**	
Title and Author	**Pages**[c]	**Volumes**	**Total Pages**
Kenilworth, Scott	477	7	1,067
Fathers and Sons, Turgenev	219	2	413
Silas Marner, Eliot	220	2	369
David Copperfield, Dickens	850	13	1,927
World Book Encyclopedia	9012 (18 volumes)	145	41,760

Exhibit 1.5. Inkprint Books and Their Braille Equivalents (Sources: (a) Library of the Perkins School for the Blind. (b) Dimensions of James Joyce, *Ulysses* (The Modern Library, 1961); picked as an example of a literary work. (c) *Cumulative Book Index*, November, 1965.)

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3. *Minutes of the Conference on Automatic Data Processing and the Various Braille Codes.* Massachusetts Institute of Technology, March 17-18, 1961, sponsored by American Foundation for the Blind and Research Laboratory of Electronics, MIT, p. 37.
4. *English Braille American Edition, 1959* (revised 1962). American Printing House for the Blind, Louisville, Ky.: p. 58.
5. *Ibid.*
6. *Ibid.*
7. "About Braille," information sheet source not indicated.
8. Krebs, Bernard M. "A Braillist Talks with Resource Teachers, *The New Outlook for the Blind,* Vol. 53, April, 1959, p. 135.
9. *Code of Braille Textbook Formats and Techniques.* Louisville, Ky.: American Printing House for the Blind, 1965.
10. Schack and Mertz, *Braille Translation System for the IBM 704, op. cit.*, p. 4.
11. *Ibid.*
12. Personal letter from Miss Ruth L. Keyes, Head, Volunteer Services Section, Division for the Blind, Library of Congress, Washington, D.C., June 6, 1966.
13. *Ibid.*

Chapter 2

The Market for Braille

Consistent statistics on blindness in the United States are unavailable. This situation exists *(1)* because of the lack of a complete, centrally-administered census of the blind; *(2)* because of the existence of a multitude of definitions for blindness with an ensuing discrepancy in numbers depending upon which definition is used; and *(3)* because many of the blind are unknown to the blind service agencies. Thus, except for a few states which try to keep an accurate census of their blind—and even these states have problems with being consistent—statistics on blindness are, at best, either rough estimates or figures having application primarily to the group which has taken them.

There are three major sources of statistics on the total number of blind in the United States.

1. *United States National Health Survey:* This survey bases its census on those who claim to be unable to read ordinary newsprint with glasses. It estimates that there are approximately 988,000 severely visually impaired persons in the United States.[1] There is reason to believe, however, that perhaps half of these could be eliminated from the total by their using proper optical aids.[2]

2. *Model Reporting Area for Blindness Statistics:* This census is based on the legal definition of blindness: 20/200 vision or less in the better eye with best correction, or a field of vision less than 20 degrees.[3] The Model is administered by the National Institute of Neurological Diseases and Blindness of the United States Public Health Survey. Figures are tabulated from the registers of agencies for the blind of the participating states. Because, as of this writing, only thirteen states are participating in the Model Area, these statistics are presently not sufficient for a national tabulation.[4]

3. *Committee of Statistics of the Blind:* These statistics, also based on the legal definition of blindness, are comprised of a series of updated estimates made by Dr. Ralph G. Hurlin of the committee. His estimate of total cases of blindness in 1964 is 411,000. It is interesting to note that while the Model Area gives a total of 51,910 for its eleven states in 1964, the Hurlin estimate yields 75,000 for the same group of states.[5,6] In view of their completeness and their basis, the Hurlin estimates are probably the most useful for market definition purposes.

When compared to the total population of the United States, the percentage of blind, approximately one quarter of 1 percent (0.214 percent based on Hurlin's estimate, 1964), is almost insignificant. Because of the small size but great importance of the market for blind services, efficiency and economy must be stressed.

Exhibit 2.1 shows the past and projected growth of the number of total blind in the United States, which appears to be linearly increasing with time, while Exhibit 2.2 shows the geographical distribution of the country's blind. Although the present rates and growth rates of the blind differ among states, as shown in Exhibit 2.3, the geographic distribution of the blind is not unlike that of the general population.

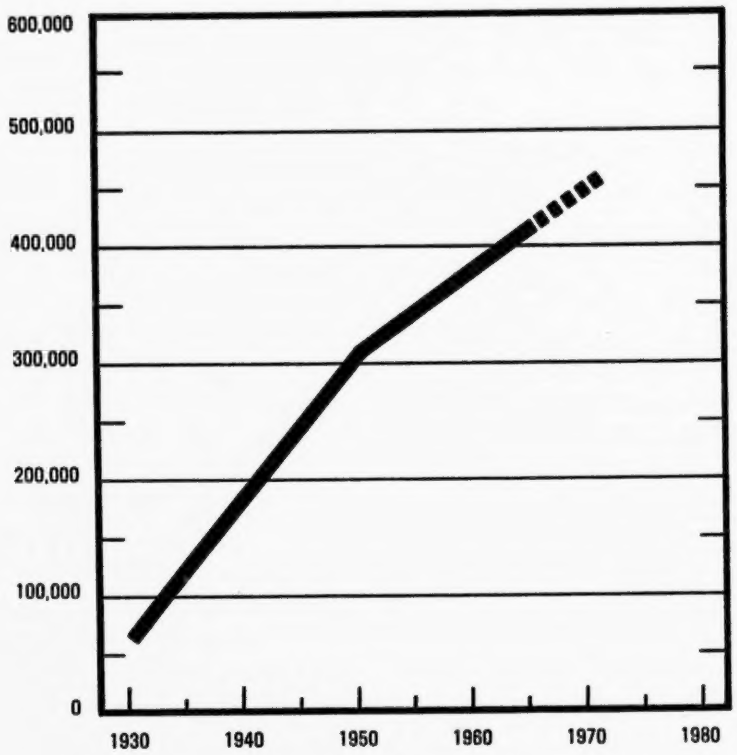


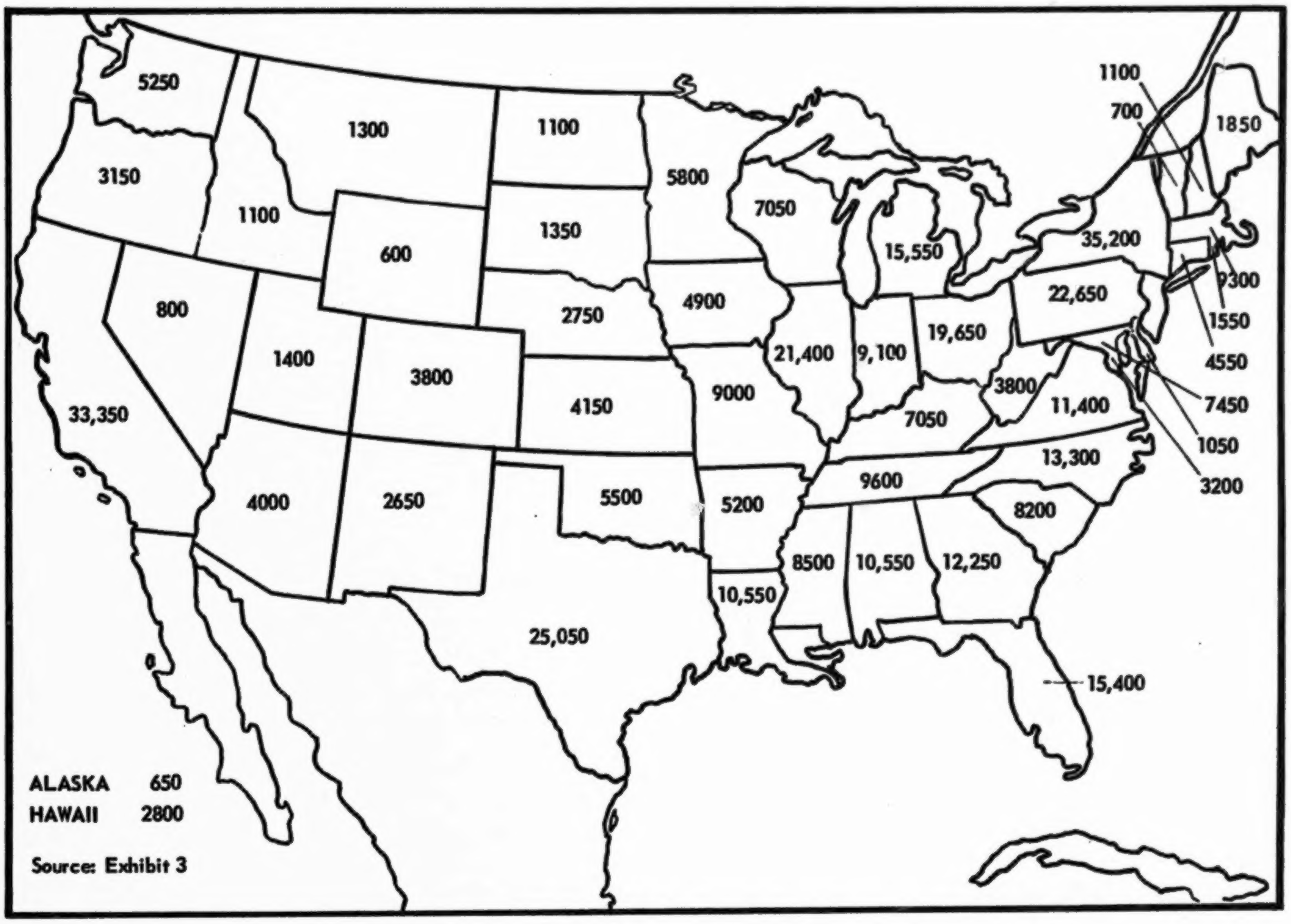
Exhibit 2.1. Total Number of Legally Blind Persons in the United States (Source: United States Census, 1930, and estimates made by Dr. Ralph Hurlin of the Committee of Statistics of the Blind.)

Another major characteristic of the total blind market is its age distribution, because the needs of the market and its character vary with the age group. Exhibit 2.4 shows this breakdown, with the 65 and over age group comprising approximately 50 percent of both present and new cases.

THE SIZE OF THE MARKET FOR BRAILLE

Accurate statistics on the number of braille readers are not available. The great diversity in the age spread and requirements of the braille market and the wide variation in the utilization of existing braille material make even a simple analysis impossible. Because of the great number of groups and individuals producing braille, the number of braille-reading individuals utilizing multiple services coupled with those not using any service at all make even a composite analysis of individual group figures impossible.

Not all of the blind need braille because many of them are able to read regular print or material reproduced in extralarge type. In fact, in most cases only those with 1/200 vision or less should be taught to read braille.[7] Because those with 5/200 vision or lower comprise only about 41 percent of the total blind population,[8] the potential market for braille consists of fewer than 160,000 people. Yet, many blind readers do not read braille at all, but, rather, use sighted readers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9300
1550
4550
7450
1050
3200
ALASKA 650
HAWAII 2800
Source: Exhibit 3

Exhibit 2.2. Geographical Distribution of Legally Blind Persons (Source: Exhibit 2.3.)

and voice recordings for their material. Then, there are those who can read braille but either have little use for it or prefer to use other methods of reading.

Actually, the use of braille by a blind person is dependent upon his present age, his age at onset of blindness, and his educational background. Reading by the blind reaches a peak in early adulthood (21 to 39 years), declines sharply in middle age (40 to 59 years), and rises to a plateau in old age (60 and over).[9] School children who must use textbooks in braille will use it much more than elderly people. Similarly, those blinded as children who must be educated using braille will be more adept at reading it and will use it much more frequently than those blinded in their later years who have neither the need nor the inclination to learn braille. Last, those whose educational background has made them heavy readers will be more apt to continue reading even after the onset of blindness.

Exhibit 2.5 shows the approximate proportions of braille users. While perhaps 25 percent of the blind can read braille, only about 11 percent, or 45,000 people, use it, and only 8 percent, or 33,000, use it as a primary reading mode.[10] As blindness becomes more of an old age phenomenon, the user percentages will decline, although absolute numbers of eligible braille readers will probably follow the population trend to a great extent. There also may be some reduction in braille reading as recordings become more widely available.

Segments of the Market

The market for braille can probably best be analyzed and serviced by breaking it down into six categories: *(1)* school children; *(2)* college students; *(3)* employed blind; *(4)* casual readers; *(5)* aged blind; *(6)* deaf-blind. Their characteristics are summarized in Exhibit 2.6.

School Children

Because the learning process is enhanced by the active reading of material, braille is the preferred textbook medium for children who are unable to read print. The number and variety of books and other reading materials which school children need throughout their

Exhibit 2.3. Estimated Total Cases and New Cases of Legal Blindness by State, 1964 (Source: National Society for the Prevention of Blindness, Inc. October, 1965.)

State	*Estimated Population July 1.1964*	*Total Cases*		*New Cases*	
		Rate[a]	*Number*	*Rate*[b]	*Number*
U.S. Total	192.072.000	2.14	411.000	16.8	32.300
Alabama	3.419.000	3.08	10.550	20.7	700
Alaska	250.000	2.65	650	16.9	50
Arizona	1.587.000	2.53	4.000	16.7	250
Arkansas	1.941.000	2.69	5.200	19.9	400
California	18.129.000	1.84	33.350	15.2	2,750
Colorado	1.975.000	1.93	3.800	16.0	300
Connecticut	2.788.000	1.63	4.550	14.8	400
Delaware	492.000	2.13	1.050	15.8	100
District of Columbia	809.000	3.93	3.200	26.7	200
Florida	5.722.000	2.69	15.400	20.8	1,200
Georgia	4.313.000	2.84	12.250	19.6	850
Hawaii	706.000	3.98	2.800	21.5	150
Idaho	696.000	1.59	1.100	13.9	100
Illinois	10.534.000	2.03	21.400	16.7	1,750
Indiana	4.846.000	1.88	9.100	15.5	750
Iowa	2.773.000	1.77	4.900	15.9	450
Kansas	2.236.000	1.86	4.150	16.0	350
Kentucky	3.172.000	2.22	7.050	16.9	550
Louisiana	3.480.000	3.03	10.550	20.6	700
Maine	994.000	1.87	1.850	16.3	150
Maryland	3.445.000	2.16	7.450	16.6	600
Massachusetts	5.359.000	1.73	9.300	15.7	850
Michigan	8.129.000	1.91	15.550	15.1	1,200
Minnesota	3.536.000	1.64	5.800	14.9	550
Mississippi	2.316.000	3.68	8.500	25.1	600
Missouri	4.425.000	2.22	9.800	18.1	800
Montana	709.000	1.82	1.300	15.5	100
Nebraska	1.486.000	1.79	2.750	16.5	250
Nevada	409.000	1.95	800	15.3	50
New Hampshire	657.000	1.70	1.100	16.0	100
New Jersey	6.697.000	1.88	12.600	15.8	1.050
New Mexico	1.012.000	2.60	2.650	15.7	150
New York	17.964.000	1.96	35.200	16.5	3,000
North Carolina	4.881.000	2.72	13.300	18.7	900
North Dakota	649.000	1.69	1.100	14.9	100
Ohio	10.138.000	1.94	19.650	15.8	1,600
Oklahoma	2.474.000	2.22	5.500	17.5	450
Oregon	1.885.000	1.66	3.150	15.4	300
Pennsylvania	11.508.000	1.97	22.650	16.3	1.900
Rhode Island	917.000	1.71	1.550	15.4	150
South Carolina	2.546.000	3.20	8.200	20.3	500
South Dakota	718.000	1.85	1.350	16.4	100
Tennessee	3.817.000	2.52	9.600	18.2	700
Texas	10.437.000	2.40	25.050	16.7	1,750
Utah	995.000	1.39	1.400	11.6	100
Vermont	412.000	1.75	700	15.9	100
Virginia	4.398.000	2.59	11.400	18.0	800
Washington	3.001.000	1.75	5.250	15.4	450
West Virginia	1.808.000	2.09	3.800	15.8	300
Wisconsin	4.129.000	1.71	7.050	15.1	600
Wyoming	345.000	1.78	600	14.4	50

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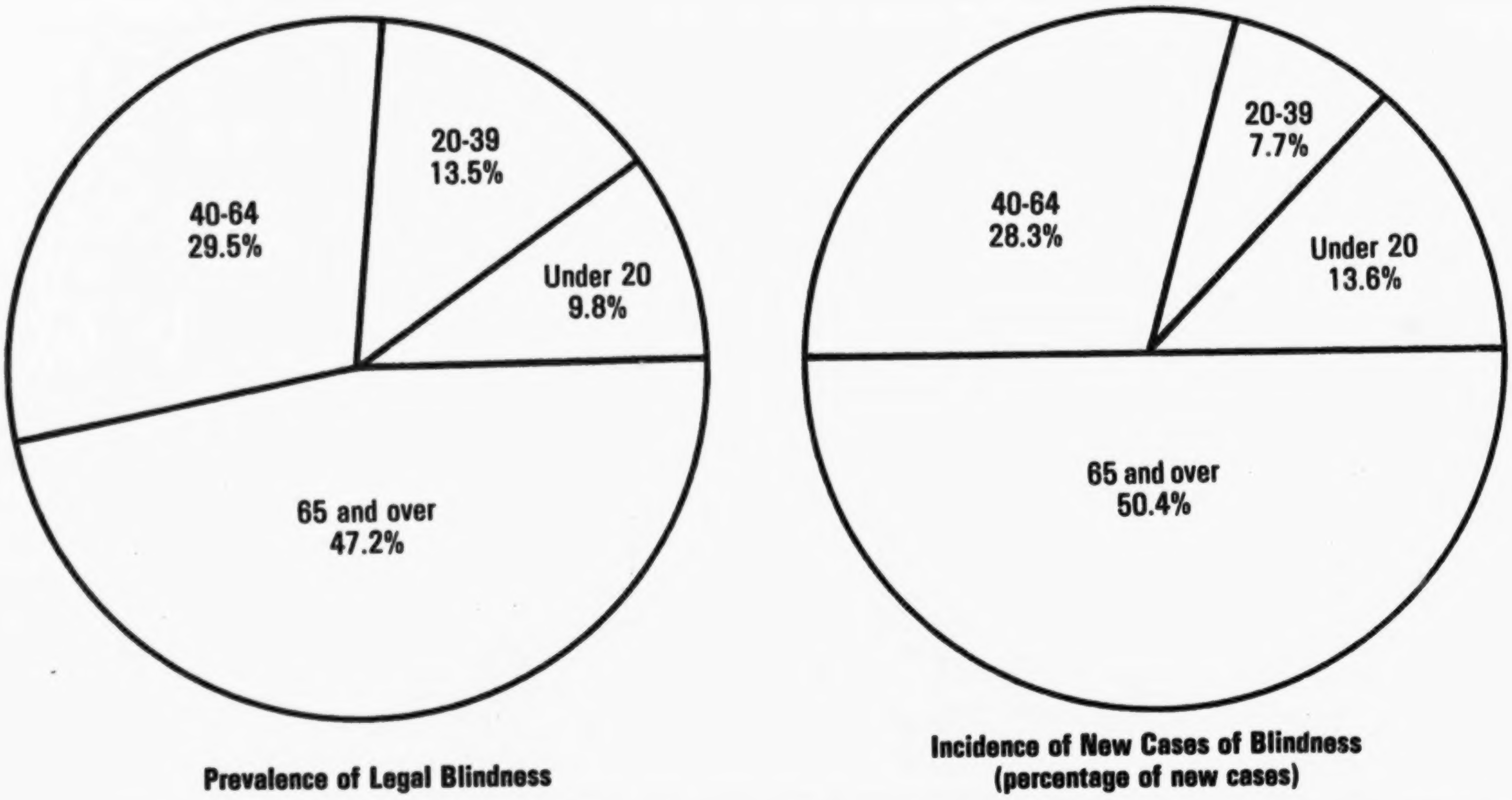
[a] Estimated rates per 1000 population as of July 1. 1960. From "Estimated Prevalence of Blindness in the United States and in Individual States, 1960." Ralph G. Hurlin. *Sight Saving Review*, Spring 1962.

[b] Estimated rates per 1000.000 population as of July 1. 1960. NSPB Statistics Department.



Prevalence of Legal Blindness

Incidence of New Cases of Blindness (percentage of new cases)

Exhibit 2.4. Prevalence and Incidence of Legal Blindness by Age Group (Source: National Society for the Prevention of Blindness, 1965.)

school years make them a major segment of the market for braille. Exhibit 2.7 shows the number of braille-reading school children registered with the American Printing House for the Blind. In addition, there are about 150 more enrolled in private and parochial schools.[11] There are thus a total of approximately 9,900 braille-reading school children, with their numbers presently growing at about 25 per year.

Sixty-three percent of these children are enrolled in residential schools for the blind which are operated specifically for blind children. The remaining 37 percent are enrolled in local public or private schools where they are integrated into the regular school curriculum in extents varying from special classes for the blind utilizing the same public school curriculum to total integration into classes of sighted children with only occasional visits from an itinerant teacher of the blind.[12] Such integration, it is felt, offers blind children an opportunity for early development of the skills and attitudes necessary for taking part in the sighted world. It also allows many of them to live at home and attend local schools.[13]

A breakdown of the numbers of braille-reading children attending residential and local schools is given in Exhibit 2.8. At present, there are 59 residential schools and 354 local public school systems with special programs for blind children.[14] Exhibit 2.9 shows the geographic distribution of all children qualifying as legally blind. Braille readers comprise about half of the total.

Although the incidence of new cases of blindness is expected to follow the general trend of the birth rate, the absolute numbers of braille readers will not follow this trend. Exhibit 2.10 shows the breakdown of braille readers by grade level for selected years. The progressive movement of the peaks to higher grades and the ensuing flattening is due to a number of factors.

Primary among these is the incidence of retrolental fibroplasia—blindness that occurs in premature babies as a result of a high oxygen atmosphere maintained in their incubators. After the institution of oxygen treatment in the 1940s, it was believed that the ensuing blindness of premature babies was a result of the premature birth. Findings in the 1950s indicated, however, that the use of the high oxygen atmosphere was the cause, and the practice was discontinued, resulting in the virtual elimination of the disease. Nevertheless, about 12,600 cases of blindness had occurred.[15] Exhibit 2.11 shows the level of major incidence.

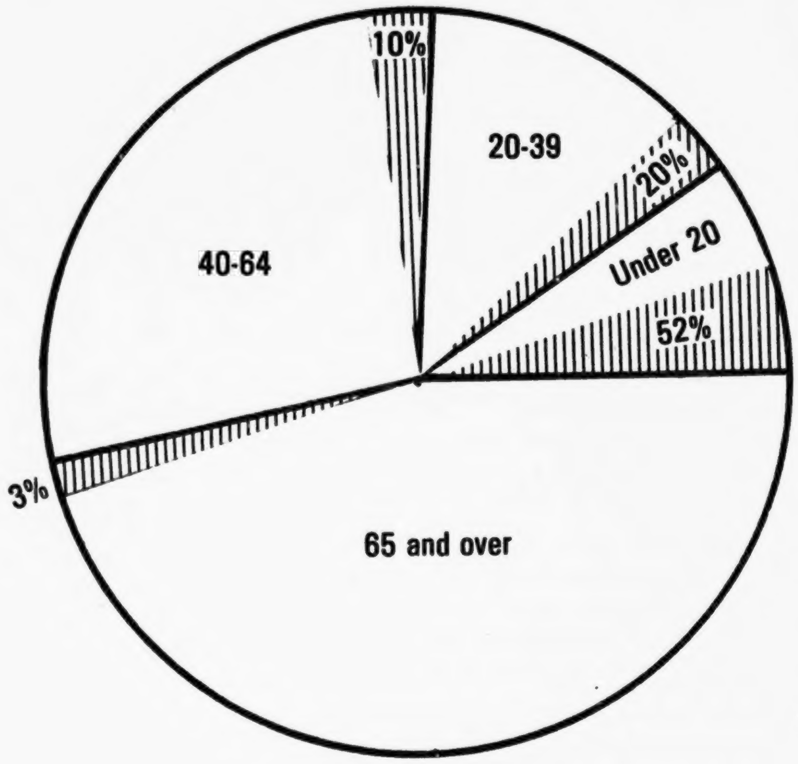
These children are presently passing through the secondary school systems, which accounts for the high peaks and the progressive movement of the peaks. The sharp increase in the postwar general birthrate, with blindness caused by other factors, has added to the total.[16] Those first becoming aware of the registration program have also caused a one-time rise in the numbers of blind children registered.[17] The large numbers of those blinded by retrolental fibroplasia presently swelling school enrollments will probably not be replaced, so that a general reduction in the number of blind school children back to the 400 to 600 children per grade level will probably occur within the next ten years.

Estimates projected beyond 1970 indicate that the number of children considered blind will drop from the present rate of 1 for every 3,000 to 4,000 school-age children to 1 for every 7,000 to 8,000. This will result not only from the graduation of those blinded by retrolental fibroplasia but also from the fact that the emphasis on education of the visually handicapped is shifting from sight conservation to sight utilization. This emphasis coupled with technological advances in optical aids is enabling many who would formerly have been educated in braille to be encouraged to utilize regular and large-type material. The result will be a reduction in the percentage of blind who read braille.[18]

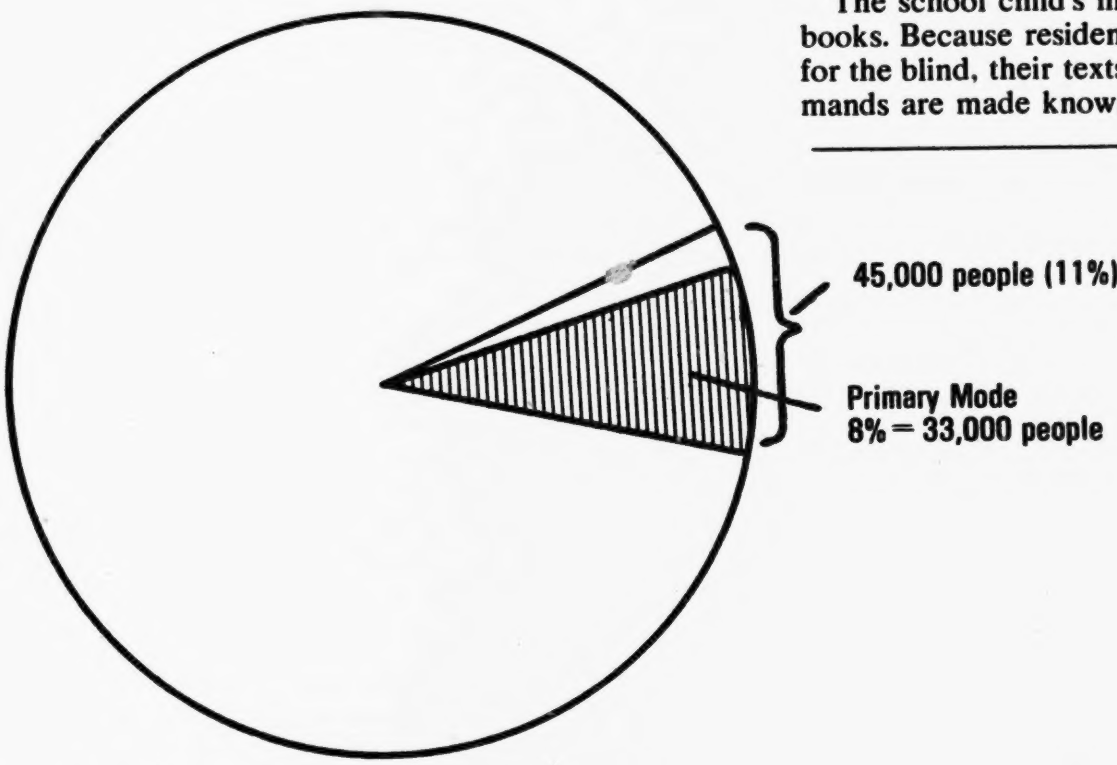
It can also be noticed that the decrease of the high first-grade peaks has been matched by an increase in the ungraded level. This represents a shift of children having low academic aptitude or mental deficiencies who had formerly accumulated in the first grade to an ungraded status.[19]

Last, the discontinuation of some programs for the blind after the sixth grade and the incidence of dropouts are factors in the tapering off of the curves at the higher grade levels. However, present emphasis on completion of high school may reduce this attrition.

The school child's main requirement is braille textbooks. Because residential schools are run specifically for the blind, their texts are standardized and their demands are made known well in advance to insure an



Proportion of Legally Blind Who Read Braille, by Age Group



Proportion of Legally Blind Who Use Braille

Exhibit 2.5. Prevalence of Braille Readers Among the Legally Blind (Source: Eric Josephson, "A Study of Blind Readers," *ALA Bulletin,* June, 1964.)

Segment	*Approximate Number of Readers*	*Requirements*	*Economic Status*	*Projected Growth*
School children	9,900	Textbooks; duplicated material; current events	Same as sighted children	Presently increasing about 25 each year. Total number may drop to about 7,000 within the decade and then grow at the same rate as the general population.
College students	1,450	Textbooks; reference material; journals and articles; duplicated material; notes	About the same as sighted college students	Number temporarily may double within the decade and then drop to almost 2,000.
Employed blind	2,500	Letters; office correspondence; journals and magazines; professional literature	About the same as or slightly lower than sighted workers in similar positions	Presently increasing at about 300 per year, and the rate may temporarily double for about a decade. Growth rate will then drop to about the same level as that of the general population.
Casual readers	14,000 but may be as high as 25,000	Books; magazines; newspapers	Lower than general average. Many of this group are supported by programs such as Aid to the Blind, Social Security or by family contributions.	Presently growing at about 1,000 per year. Growth rate will probably decrease to that of general population with 10 to 15 years.
Aged blind	6,000	Can be served as casual readers	Most of this group lives on Aid to the Blind, Social Security, or similar programs, or family contributions.	Although the number of aged blind will grow to perhaps 75 percent of the total blind population, only about 1 to 3 percent of this group will use braille.
Deaf blind	700	Fit into above-mentioned categories.		Growth will follow general population trend.

Exhibit 2.6. Braille Market Segments

adequate supply of braille texts. Public school children, however, face a great problem. Texts are chosen from the wide assortment made available by the publishers. Many of the books are very recent additions, and choices are often made only a short time before the semester starts. Consequently, it is very difficult for blind students to obtain texts, many of which must be produced individually by hand. Indeed, from 25 to 50 percent of the braille books requested by a school system may be unobtainable in time for desired use.[20,21]

Modern teaching methods utilize considerable amounts of duplicated materials, auxiliary readings such as magazines and current-event weeklies, and written examinations. Many of these are best presented in braille, and obtaining items in braille within a reasonable time is a problem here, too. Although the actual numbers of braille-reading students may decline, this decline is being partly offset by the increasing amount of braille material which they require.

College Students

There are no special colleges for the blind, and, as a result, blind students wishing a college education are totally integrated into the sighted collegiate world. No special statistics are available on college students, but Recording for the Blind, Inc. served 1,451 blind college students in 1965, many of whom probably read braille also. With about 400 braille readers presently in twelfth grade, the 1,451 number is perhaps a reasonable approximation of the number of braille readers in college.

The number of blind, braille-reading college students will probably begin to rise considerably as those blinded by retrolental fibroplasia enter college. With the increased emphasis on college education and graduate work, the number of college student braille readers may double as the peak of those blinded by retrolental fibroplasia reaches college age. Within ten years after that, however, the numbers will probably decrease again to around 2,000 students.

Because of the difficult nature of college texts, which require slow and careful reading even in inkprint, and because braille is the most effective medium for presenting technical, mathematical, and other highly-symbolic material, the demand for braille by college students is very high on a per capita basis. College texts in braille are even more difficult to obtain than primary and secondary school texts because not only is the variety of titles great and the lead time before use short—even shorter than for school texts—but technical braille and specialized formats require special brailling

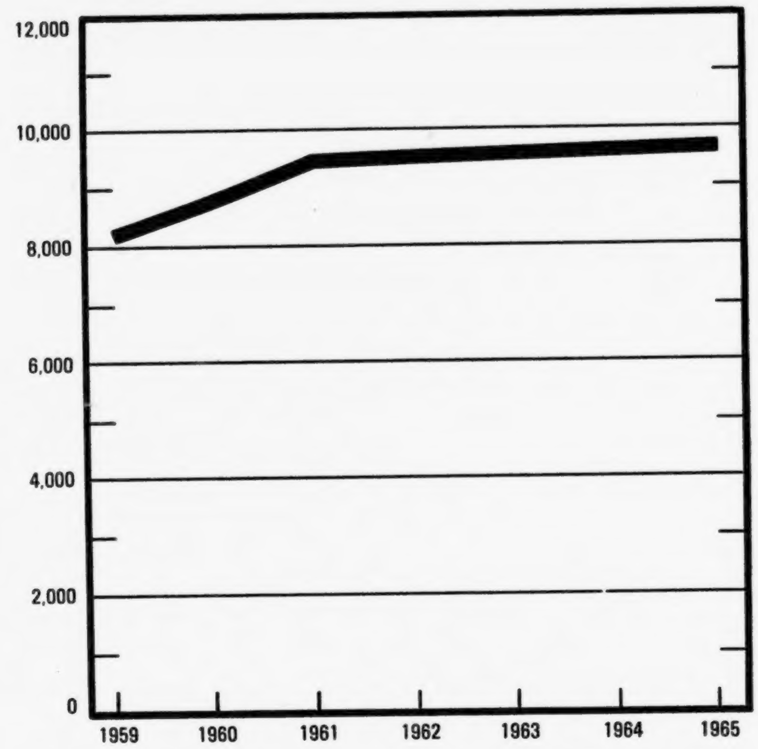


Exhibit 2.7. Braille-Reading School Children Registered with the American Printing House for the Blind (Source: Data supplied by American Printing House for the Blind.)

skills which have been mastered by perhaps 25 braillists in the country.[23]

In addition to textbooks, college students often require braille copies of reference material, outside readings, journals and articles, duplicated materials and notes, and examinations, all of which make the college-student demand for braille a significant one.

Employed Blind

Of the 411,000 legally blind people in the United States, almost half of whom are over 65, approximately 80,000 are either employed or performing their duties as homemakers. Their fields of employment include the range of positions found in the competitive labor field as well as jobs in sheltered workshops for the blind. Their geographic distribution is about the same as that of the general working population; however, large urban areas offer more employment opportunities for the blind than do other areas.[24] Exhibit 2.12 gives an indication of the distribution of occupations among the legally blind.

Because only 20 percent of the 20 to 64 age group are braille readers, and because the employment rate for the severely visually impaired blind, which braille readers are, is lower than that of the legally blind as a group,[25] there are probably fewer than 10,000 active braille readers in the job market. Of these, only those working in jobs that require considerable reading, mainly those in professional and clerical positions, would need braille for their work. Thus, perhaps 25 percent of these, or 2,500 employed blind, actively use braille in their work. Estimates given by those familiar with the employed blind tend to support this figure,[26] and a study of white-collar blind employees indicates that about 60 percent found braille necessary for their work.[27]

Figures on rehabilitation programs for training the blind [28] and those given earlier on graduates from educational institutions indicate that the number of employed requiring braille for their work may presently be increasing by perhaps 300 per year. This figure may more than double in about ten years as the peak of those blinded by retrolental fibroplasia enters the job market. Although the greatly increased growth rate will be sustained for only about a decade, the continued service for these people once in the job market will mean a great increase in the amount of braille which will be required by the employed blind. Also battle casualties arising from continued military activity by this country may add to the number of employable blind.

The employed blind require braille copies of significant letters, memoranda, and other office correspondence as well as brailled books, journals and house organs, and professional literature. With an increasing number of employment opportunities now being opened to the blind, the success of many blind workers will be dependent upon a rapid, convenient source of braille.

Casual Readers

Like sighted persons, braille readers also read for pleasure, although the sources of braille books are much more limited and the number of titles available is but a fraction of those available to sighted people. While

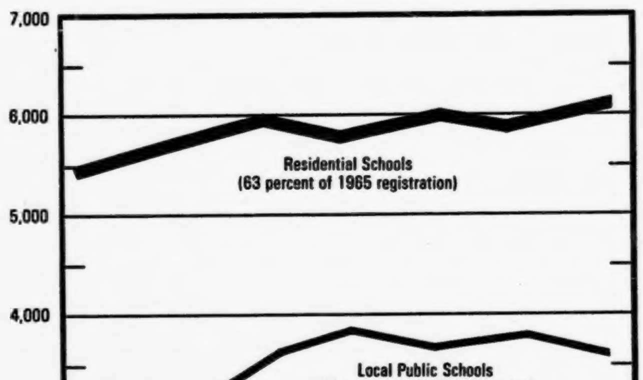


Exhibit 2.8. Braille-Reading Children Registered with the American Printing House for the Blind by Type of School (Source: Data supplied by American Printing House for the Blind.)

braille books for casual reading are available from private organizations and braillist groups. the largest source of such books is the Library of Congress which circulates recreational braille reading material from 28 regional libraries. The location of these libraries and the number of active braille readers utilizing the service are given by state in Exhibit 2.13. The totals of active braille readers utilizing the Library of Congress service for the past few years is shown in Exhibit 2.14.

Although the number of active braille readers has been rising steadily, the present level of over 14,000 is less than half of those using braille as a primary reading mode and less than one third of those able to read braille. There are a number of reasons for this situation. A major reason is that, just like the sighted in this country, the blind, expecially in view of their added handicap, do not do much recreational reading. Many adult blind have done no reading since they became blind, and fewer than one fifth of the total blind prefer reading as their favorite pastime.[29] Nevertheless, more than half of those surveyed in one study read at least one book per month and about one third read at least four books per month. [30]

A preference by the blind for voice recordings for light reading is also a great factor in limiting the number of casual readers of braille. The small number of current titles and the fact that the blind usually cannot go to the library and select books, but, rather, must usually select by mail with scant knowledge of available books, also limits readership.

However, the number of active casual braille readers is growing, and, no doubt, there are many additional casual readers who do not patronize the Library of Congress. The number of casual braille readers will probably continue to grow at the present rate for perhaps another decade as more blind become familiar with the Library of Congress programs and as students blinded by retrolental fibroplasia, who are accustomed to reading and using braille, graduate and have time for leisure reading. Although the rate of growth after the decade will probably return to levels approximating the normal population increase, total readership will probably have doubled because those who will have contributed to the excessive growth rates will still need service for many years to come.

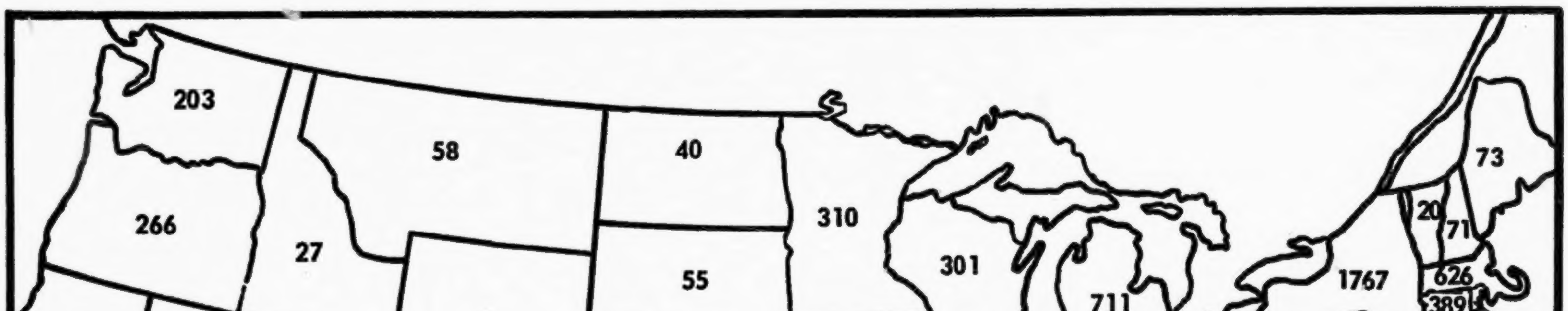


Exhibit 2.9. Geographic Distribution of Legally Blind Children (Source: Annual Report of the American Printing House for the Blind.)

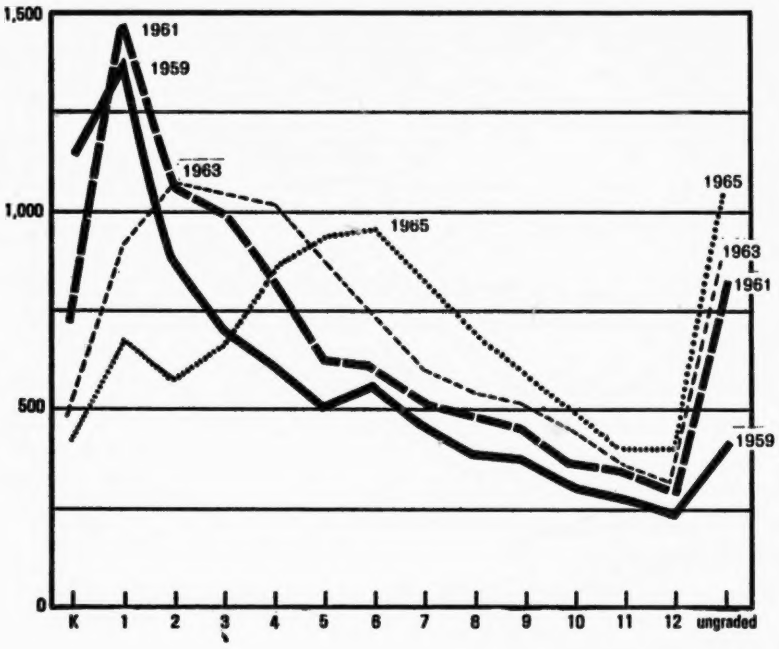


Exhibit 2.10. Braille-Reading School Children by Grade Level for Selected Years (Source: American Printing House for the Blind.)

The needs of casual braille readers usually extend to popular fiction and nonfiction titles, religious material, current magazines, house organs, and newspapers, and braille musical scores. Obtaining current material is a major consideration here. In addition, personal correspondence is often carried on in braille. Exhibit 2.15 shows that along with the increase in readers, there has been an increase in circulation per reader. This means that there will be an even greater demand for brailled recreational reading material in the future.

Aged Blind

Although the blind over 65 years of age comprise almost 50 percent of the total blind, only 3 percent of this group read braille. A primary reason for this is that over half of these people became blind as a result of old age, and almost 80 percent became blind after the age of 40. Because they were not schooled in braille and have no pressing need for it, most of this group have no desire to learn braille, and many of them do not have the perseverance or capability required to learn it. Thus, the aged blind are probably not a significantly large market for braille among themselves, and can best be served as are the casual readers. Although the aged blind will grow in number, it is doubtful that they will ever form a large market for braille, and, in fact, they will probably utilize readers or voice recordings for most of their reading.

Deaf-Blind

The deaf-blind do not have any special requirements, but, rather, fit into the categories already mentioned. For those deaf-blind who do not have sufficient vision to read print, all their reading material, other than that slowly communicated via the manual alphabet, must be in braille. There are about forty braille-reading deaf-blind children[31] and perhaps 700 deaf-blind braille readers in the United States out of about 4,000 deaf-blind total.[32] This number will probably grow at the same percentage as the general population.

CHARACTERISTICS OF THE MARKET FOR BRAILLE

A number of factors exist that make the market for braille unlike the typical consumer market. Although the braille-reading population is small, widely scattered, relatively immobile, and heterogeneous in its requirements, no segment of this market can be abandoned because, for these people, braille is essential.

Market Appeal

Characteristics within braille itself limit the attractiveness of braille to many prospective users. The difficulty involved in learning and the slow reading speed cause perhaps half of the potential readers to disregard braille completely and to consider only sighted readers or voice recordings for their reading media. Some attach a stigma to braille, because it was developed specifically for the blind, and refuse to admit to the need for it.

Another major factor in reducing the appeal of braille is the highly limited access to sources of braille which, by virtue of the small yet widely-separated market and

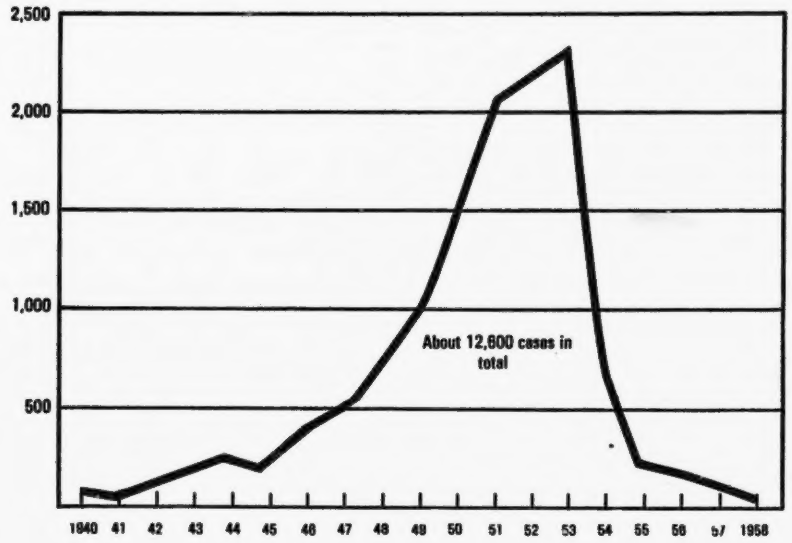


Exhibit 2.11. Number of Cases of Blindness Resulting from Retrolental Fibroplasia (Source: Based on New York State Census of the Blind, 1958, and national total supplied by National Society for the Prevention of Blindness.)

the limited mobility of the blind, is very difficult to overcome. The small number of titles available and the long time necessary to obtain current material add to the lack of appeal of braille and reduce motivation to learn it. Also, because of this limited access, adults who could benefit from braille but do not absolutely require it may not even be aware of the amount of braille and the brailling programs that do exist.[33]

There is some disagreement as to the interaction of access and demand among braille readers. One feeling is that the blind actually do more reading than the sighted because the blind have fewer diversions.[34] Increasing the availability of braille titles and the access to braille sources would provide more motivation for learning and using braille, and demand would rise.

The other feeling is that reading is not a popular activity of sighted people, and it is even less so among the blind. Also, voice recordings are usually preferred for general reading. Thus, increasing the amount of braille and access to it would do little toward creating new demand. [35] There have been no attempts to test these opinions as yet, however.

Economic Aspects

The economic aspects of the braille market are also unlike those of the normal consumer market. Braille production, where it is paid for, is a nonprofit business, and a considerable amount of braille is produced free of charge, either having been subsidized or provided by volunteer braillists. As a result, prices cannot be altered for the braille market as they can be for the consumer market.

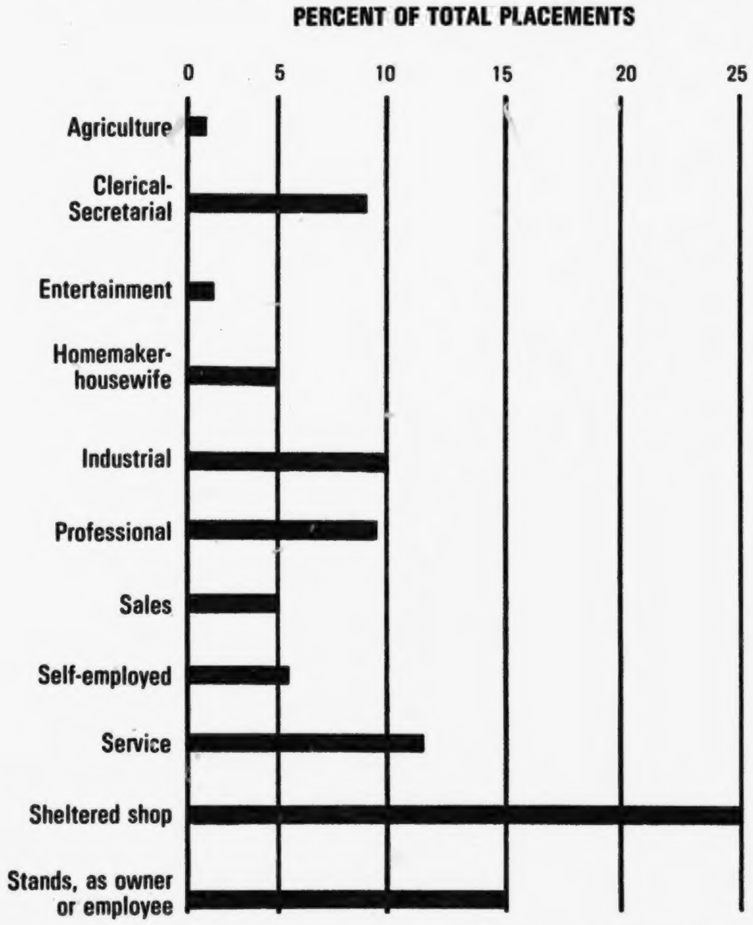


Exhibit 2.12. Occupational Distribution Among the Employed Legally Blind (Source: New York State Census of the Blind, 1958.)

Nevertheless, if changes in the braille production system entail an expense on the part of braille users, some indication of the economic situation of these people is needed. The market segments employed earlier are also useful here.

The school-age blind come from normal families so that their economic status—actually that of their family—is of the same distribution as that of the country as a whole. In addition, legally blind school children are aided by the quota, a government grant, presently of about $44.21 per child, which is given to the American Printing House for the Blind to be used for educational materials for the blind by the school in which the child is enrolled. Often further subsidies are given by state, local, or service organizations. While such funds do not always cover all of a child's extra educational expenses, this assistance is significant enough so that the economic status of the families of blind school children can probably be considered as adhering to national norms. The added special expenses connected with blindness may be offset by reductions in other expenses such as recreational toys, movies, and similar items.

College-age blind students also come from normal economic background; however, they usually incur special educational expenses connected with blindness. Braille textbooks for college students are usually produced by volunteer braillist groups who may supply the books either at no cost or at prices ranging up to the complete cost of materials and binding—the approximate full cost often being up to about double the price of the original inkprint text. Also, some college students hire sighted readers, whereas others utilize volunteer services. Yet these added costs of education may be offset by reduced expenditures for recreation and travel. Thus, for market estimations, the economic status of braille-reading college students can probably be considered similar to that of their sighted peers. While state and Federal aid to the blind programs do exist, these are primarily for those needing income subsidy, and only 4 percent of the recipients, encompassing perhaps 500 braille readers, are below 25 years old.[36]

The status of those children blinded by retrolental fibroplasia deserves special mention. In many cases this disease was the result of the care and treatment routinely available to middle-class and upper-class families.

In addition to having above-average income, these families are usually more aware of innovation in services and aids for their blind children and are eager to take advantage of the advances. The tradition of education and innovation-awareness both in the parents and as passed from parents to children coupled with above-average income and motivation may make for higher

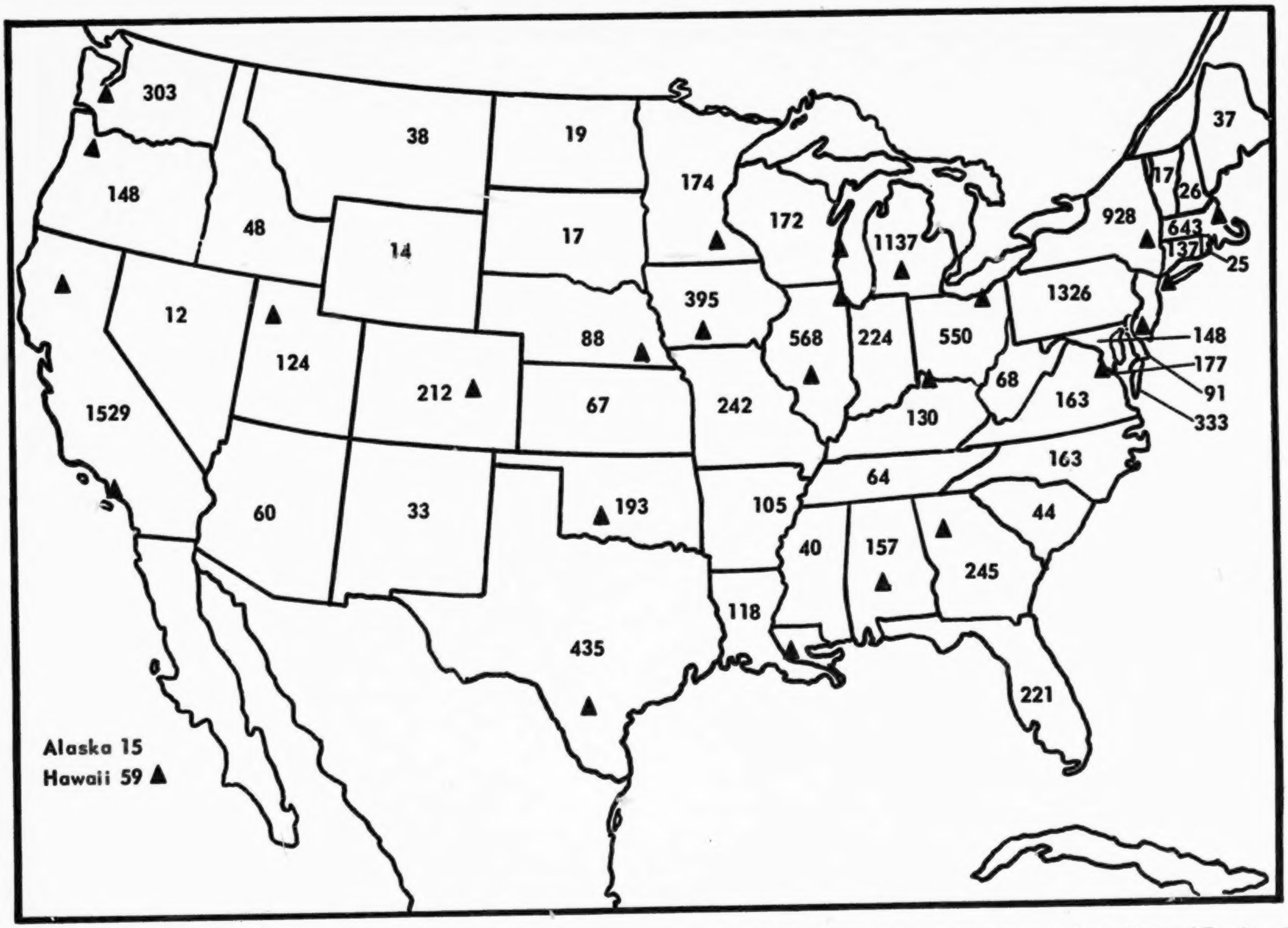


Exhibit 2.13. Geographic Distribution of Casual Braille Readers Using the Library of Congress Services and Locations of Regional Libraries (Source: Library of Congress, Division of the Blind, 1965.)

than normal market potential in the retrolental group both presently as students and in the future as adults.[37]

Unlike school children and students whose economic support is provided by their family, the economic status of the adult blind is dependent upon the earnings of these adults. Thus, their employment situation is a major factor. Unfortunately, statistics on the income of the blind are very few. For those blind who are active braille readers and are employed in competitive occupations, their incomes probably are in line with those of sighted workers in the same occupation. However, as shown in Exhibit 2.12, about 40 percent of the employed blind work in sheltered shops, where wages average about $1.25 per hour,[38] or in vending stands, so that their wages may be below normal averages.

According to one study, only 26 percent of the severely visually impaired lived, unaided, on their own or their spouse's income,[39] and the figure for braille readers is probably even lower. Approximately one quarter of the total blind receive Aid to the Blind with payments ranging from $46.72 to $145.02 per month, depending upon state of residence, and averaging about $92.00.[40] Almost three quarters of these are over 50 years of age.[41] About half of the severely visually impaired blind in the study lived on Social Security pensions, Old Age Assistance, and similar programs, and family contributions also accounted for some of the support of the blind.

It thus appears that among those who are active braille users, school children, students, and the employed blind can be considered to have an economic status in line with national norms whereas perhaps one half to three quarters of the casual readers have below average incomes. This must be considered in marketing new devices for braille readers.

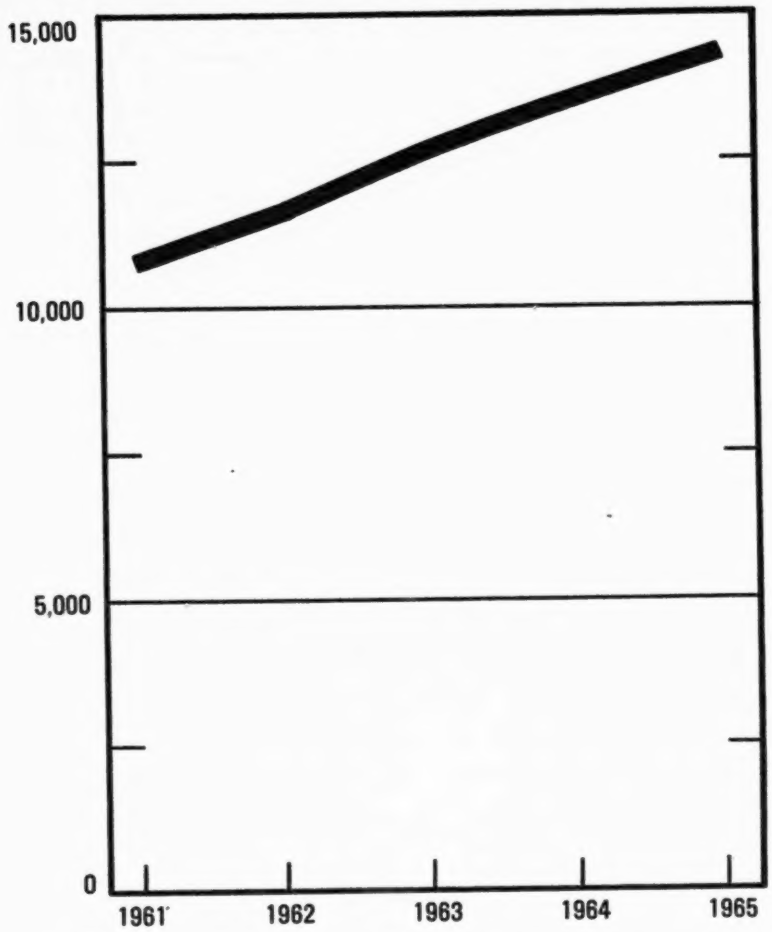


Exhibit 2.14. Number of Casual Braille Readers Using Library of Congress Services (Source: Library of Congress, Division of the Blind.)

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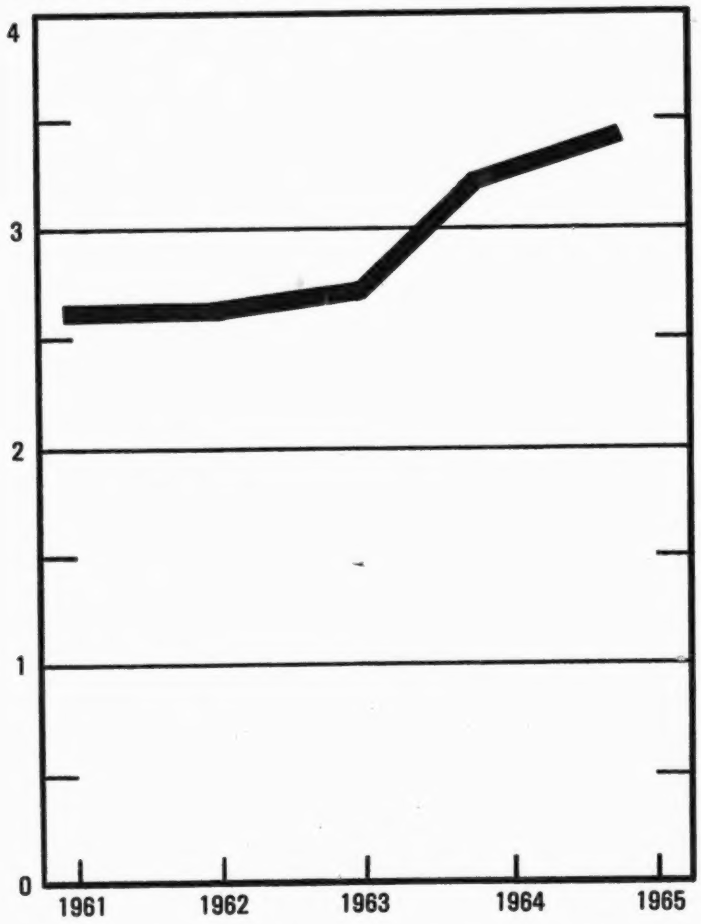

Exhibit 2.15. Circulation Per Reader (Volumes) for Casual Braille Readers Using Library of Congress Services (Source: Library of Congress, Division of the Blind.)

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Chapter 3

Sources of Braille

The sources of braille range from the individual braillist, who may transcribe material for just one person, and small, local braillist groups to large, nationally coordinated braillist organizations; and from small, special-purpose, privately financed braille publishing organizations to large, federally aided braille presses. These brailling programs are administered by an assortment of independent Federal, state, local, religious, and philanthropic organizations.

PRODUCERS OF BRAILLE

Braillists

Except for a very small amount of braille being translated from inkprint by computer on an experimental basis, all braille, be it single-copy material or master plates for a press run, is produced by braillists. These are people—the majority being women—who have been trained to transcribe inkprint material into braille.

A braillist must be certified by either the Division for the Blind of the Library of Congress or by an organization authorized to grant certification. To become a skilled, certified braillist is an arduous task. Braillist training is rigorous and exacting, and the material is difficult. Instruction in braille transcribing is taken either in local classes given by organized braillist groups or through correspondence courses. The material and course outlines for both types of classes are usually supplied by the Division of the Blind of the Library of Congress. The Division also administers the correspondence courses.

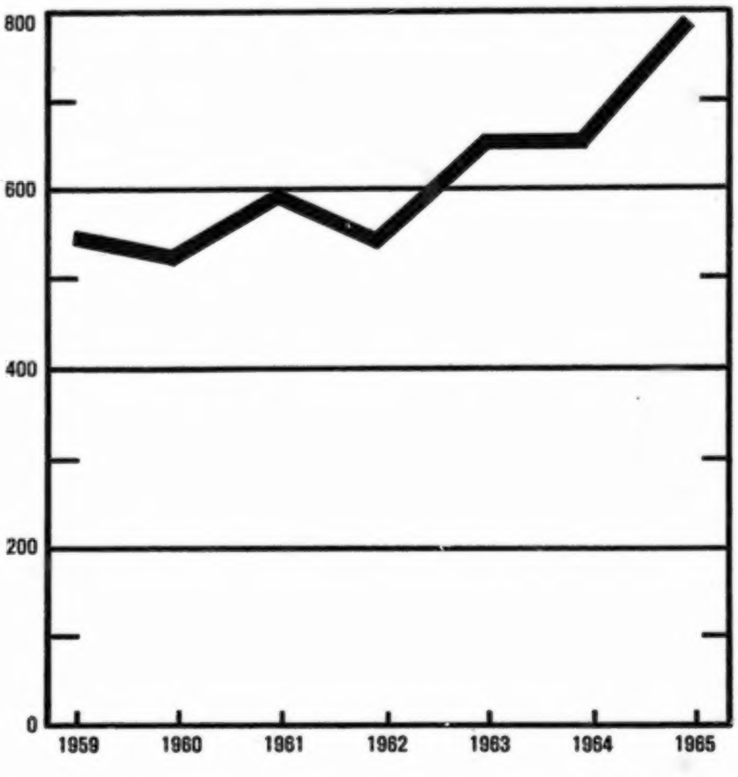

Exhibit 3.1. Braillist Certificates Awarded by the Library of Congress (Source: Annual Reports of the Librarian of Congress.

Enrollment for braille training is purely voluntary, and students usually assume all costs for braillewriting equipment and materials. Braillewriting equipment costs can range from four dollars for a simple one-dot at-a-time braille slate and stylus to up to ninety dollars for a mechanical braillewriter.[1] Also, the student must have considerable leisure time which can be devoted to the study of braille and to the transcription of material.[2]

The course in literary braille consists of 19 lessons which cover every phase of common literary braille. Only two opportunities are given to submit any one lesson because experience has shown that students who fail to submit a satisfactory lesson by the second attempt do not possess the characteristics essential to a proficient transcriber.[3]

Upon completion of the final lesson, the course usually requiring an average of about six months of study, the trial manuscript—the final examination—is submitted to the Library of Congress or to an authorized certifying body. Up to three different trial manuscripts are allowed to be submitted by any one student, and should the third trial prove unsatisfactory, no further opportunity can be given to receive certification.[4]

Because standards of braille transcribing which will assure blind readers of accurately produced books must be maintained, only those students whose workmanship is of high quality can hope to receive certification. An average of fewer than 70 percent of those who enroll in the braillist training program receive certification.[5] Exhibit 3.1 shows the number of braillist certificates awarded annually by the Library of Congress.

Even after certification it often takes almost two years before a braillist becomes truly proficient at her work. Should a braillist desire to transcribe braille codes other than the standard literary code, such as the mathematics and scientific code, braille music, or foreign languages, even further study and practice are required. In addition, special training in braille proofreading is offered by the Library of Congress to qualified persons who are already proficient braillists. Exhibit 3.2 shows the number of proofreader certificates awarded annually.

Braillists are extremely dedicated workers as evidenced by the fact that most enroll for the rigorous training program as a purely voluntary effort and solely to be able to volunteer their time in service to the blind.

At present there are approximately 6,000 braillists certified in the literary code, although not all are active. About 1,200 live in New York state and about 600 each in New Jersey and California.[6] Eighteen braillists are certified to transcribe braille music[7] and there are over 160 certified proofreaders.[8]

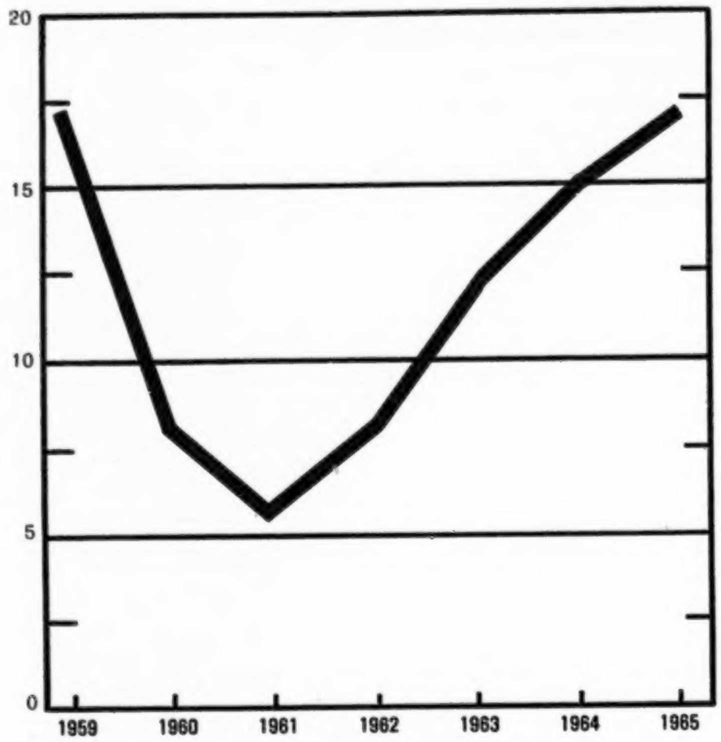

Exhibit 3.2. Proofreader Certificates Awarded by the Library of Congress (Source: Annual Reports of the Librarian of Congress.)

Braillist Groups

The great majority of certified braillists provide their services free of charge and often pay for materials such as paper and binders. Although some of the volunteers operate independently, producing braille for blind individuals or for organizations, most are affiliated with braillist groups throughout the country. Groups may range in size from a local organization with only a few members to the large National Braille Association which has over 2,300 members in 49 states and Canada.[9] Organizations are sponsored by sisterhoods, churches, Red Cross chapters, special education classes in universities, rehabilitation agencies, and service groups. Some Federal and state prisons also have active braillist organizations.[10]

There are over 280 braillist groups in the United States. Exhibit 3.3 shows their distribution by state, California and New York having the greatest number. Exhibit 3.4 lists the numbers of braille groups with specialties in addition to the literary code.

Braillist groups perform many duties. They provide, on request, braille material for individuals in their area. They also provide copies of books requested by the Library of Congress, braille presses, or service organizations. Some groups publish periodicals, pamphlets, newsletters, and magazines for the blind. Fifty-six have duplicating services whereby duplicate copies of existing braille books can be produced with special vacuum-forming equipment.

The output of the braillist groups varies widely according to their size, location, and activity. For example, in 1964 the National Braille Press in Boston, Massachusetts, which has about 400 members, produced 189,000 pages of braille and 34,000 duplicated pages.[11]

Braille Presses and Publishers

Braille presses and publishers produce multiple-copy braille material. At present there are twenty-one major groups of this type. Fourteen of these are organizations of varying sizes supported by religious groups who supply brailled bibles, religious books, pamphlets, and magazines. Some actually produce the brailled material themselves whereas others are merely publishers, contracting out the production of their material to braille presses or volunteer groups. Three of the twenty-one are similar, privately supported organizations which provide braille educational material or newsletters for the blind.[12] Exhibit 3.5 lists the names and specialties of these organizations.

The majority of the multiple-copy brailled material is produced by the four large braille presses also listed in Exhibit 3.5.[13,14] All are privately supported. Braille is transcribed by hand by braillists who are employed by the braille presses. In this case, however, the braille is usually transcribed onto zinc plates which are used as press masters.

The braille presses produce an assortment of braille textbooks, fiction and nonfiction books, popular magazines, newsletters, house organs, and reference material. The assortment and supply, however, are very limited. In 1964 the annual output of press-braille books, for example, comprised perhaps 200,000 braille-plate pages,[15] which corresponds to about half as many inkprint pages.[16] Assuming an average of approximately 300 inkprint pages per title, this means an annual production of fewer than 700 titles in press braille. (This does not include volunteer and hand-transcribed titles.)

Compared with almost 28,500 inkprint books published in the United States in 1964,[17] this implies a least-common-denominator basis for choosing press-run titles.[18] Another consideration is that a typical press run was only about thirty copies[19] which, considering the approximately 45,000 active braille readers, implies great difficulty in obtaining popular titles.

Similarly, fewer than about fifteen music selections are embossed in press braille annually,[20] and about one hundred magazine and periodical titles are produced, perhaps ten of which are popular magazines, the rest being educational material and house organs for the blind published by schools for the blind and by blind service organizations.[21] (This does not include volunteer and hand-transcribed titles.) When one considers that 20,000 periodicals are published in the United States and Canada, the number available to the blind is insignificant.[22]

The largest of the braille presses is the American Printing House for the Blind in Louisville, Kentucky, which produces about 75 percent of the braille-plate pages in the United States.[23] Although it is a private organization, the Printing House has also been designated as the official source for all braille textbooks and materials supplied under the aid-to-blind school children quota of the United States Government. In addition to its own publishing program and that of the Government, the Printing House also does contract braille printing for many blind service organizations. Exhibits 3.6 through 3.8 indicate the annual output of braille by the Printing House. The annual fluctuations in these figures are due to changes in demand, costs, production facilities, and similar factors.

In 1959 there were 4,000 braille copies a month of the *Reader's Digest*, which has probably the largest run of any braille publication,[24] the same year the Printing House published seventy braille magazines including eight weeklies.

The Clovernook Printing House for the Blind, which does mostly contract work for blind service agencies, produces about twenty million pages of braille annually and twenty-five braille magazines.[25,26]

Other Producers

When groups or individuals have persistent requirements for brailled material, they often hire the services of full-time braillists. Thus, public school systems with a sufficient number of blind students to insure constant demand will employ braillists to transcribe tests and handouts frequently distributed to students as well as to transcribe hard-to-get text material. These braillists may either be assigned permanently to a school or be employed in an itinerant capacity and serve a number of schools. Often the teacher who provides the special services for the blind children in a school or school system also serves as a braillist. Schools for the blind may have resident braillists to transcribe teaching material.

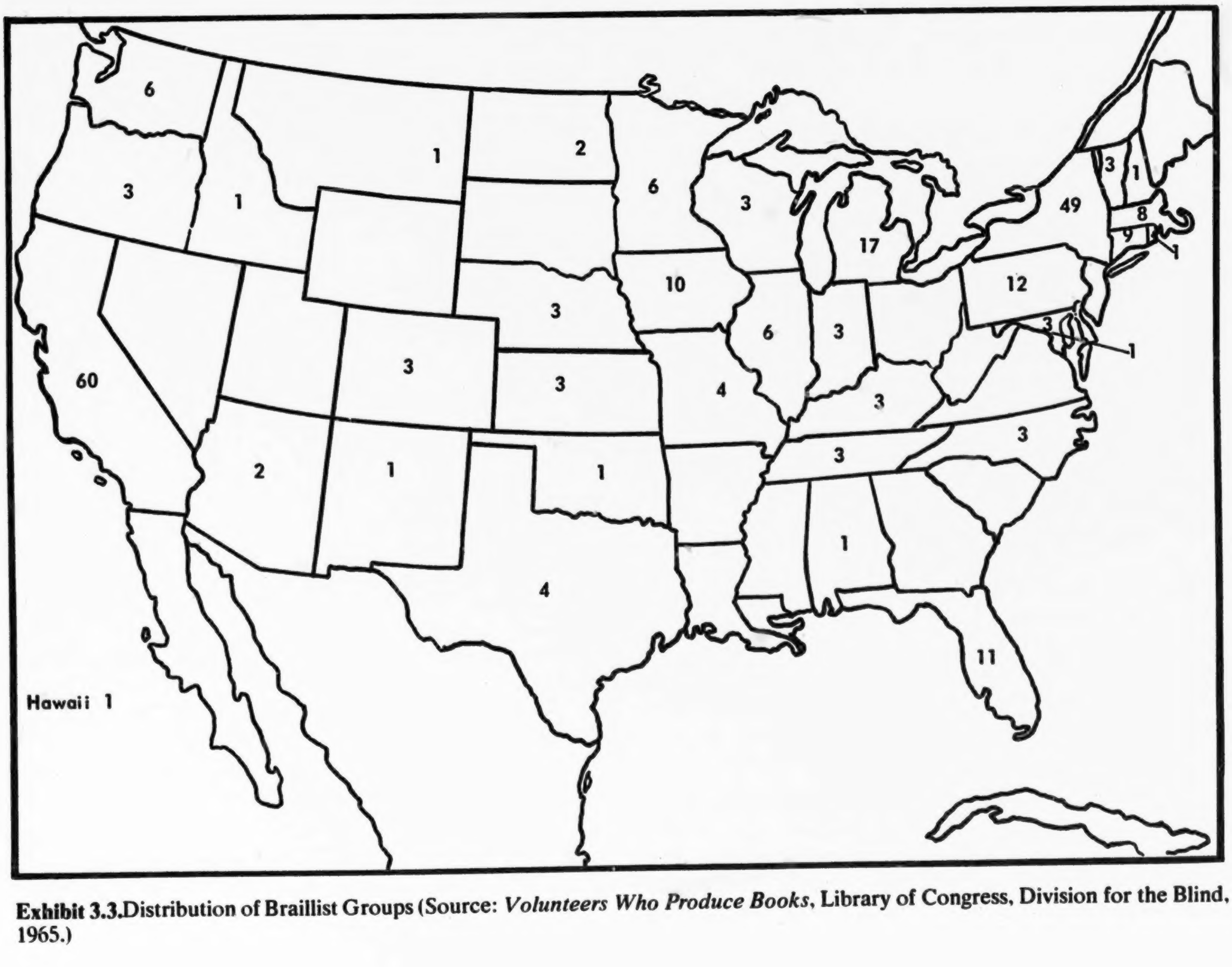

Exhibit 3.3. Distribution of Braillist Groups (Source: *Volunteers Who Produce Books*, Library of Congress, Division for the Blind, 1965.)

Specialty	*No. of Groups*
Languages	
Bahai	3
Bemba	3
Esperanto	3
Gaelic	2
German	39
Greek	7
Hawaiian	4
Hebrew	17
Italian	10
Japanese	4
Latin	34
Lithuanian	2
Portuguese	3
Russian	8
Spanish	70
Chemistry	1
Mathematics	68
Music	32
Science	47

Exhibit 3.4. Braillist-Group Specialties (Source: *Volunteers Who Produce Books*, Library of Congress, Division for the Blind, 1965.)

Similarly, blind individuals such as college students or businessmen may have constant requirements for braille materials on short notice and thus may employ a full-time braillist.

In recent years another service to the blind readers, that of making copies of existing books, has increased the availability of brailled books. Books that have been transcribed but are in private hands or are in short supply are borrowed by the copying group which rapidly duplicates them on vacuum-forming machines, returning the original to its owner and forwarding the duplicate to the requester. As of 1965, fifty-six braillist groups provided such a service.[27]

BRAILLE BOOK SOURCE INFORMATION

Because of the extremely limited supply of braille titles and copies thereof, and the widespread geographic distribution of braille book users, book requests are usually checked in a catalog or submitted to a book clearing house or union catalog as a first step in requesting a book.

Catalogs

Braille publishers that offer a wide line of publications as well as the braille presses that produce material for sale or public distribution often publish catalogs. The most extensive is the 206-page *General Catalog of Braille Publications, 1966,* which lists the approximately 5,000 books of all types offered by the American Printing House of the Blind. The Printing House also offers a *Catalog of Music Publications, 1957* (with 1963 supplement), which contains 143 pages listing scores for all purposes.

The National Braille Association publishes a catalog of its NBA Braille Book Bank. The Book Bank provides copies of college-level textbooks and professional literature in braille. At present, the catalog contains about eighty listings. Some organizations offer not only books and periodicals but also other brailled aids such as mathematical tables, Regents examinations, and College Entrance Examination Board tests. Even accredited correspondence courses in many subjects are available.[28]

Clearing Houses and Union Catalogs

The braille book clearing houses and union catalogs serve two purposes. First, they avoid needless duplication of efforts by coordinating the work of braillists throughout the country. Braillists first check with the appropriate coordinating organization before starting to transcribe a book to insure that it has not been done before or is not in process. They then file their intent-to-braille with the organization.

Second, these organizations serve as sources of information on which books have been transcribed and where they can be obtained. Requests are sent either by title or by subject matter to the central organization, and the organization indicates whether the book has been brailled and which libraries or individuals possess a copy.

If the book is available, the requester then contacts the appropriate owners and makes arrangements to obtain a copy either by purchase, by loan, or by vacuum formed duplication. If the book is not available, the requester may attempt to have it transcribed by a volunteer braillist.

There are three major central information sources for braille books:

1. *General Catalog of Volunteer Produced Textbooks:* This central catalog is administered by the American Printing House for the Blind in Louisville, Kentucky. It is the union catalog of all textbooks that have been and are being transcribed into braille; no other types of books are catalogued here. Because the catalog was begun only in 1959, and before that there had been little coordination among the many braillists and groups, there are omissions. Nevertheless, every effort has been made to secure the cooperation of braillists to insure accurate reporting.

The *General Catalog* presently contains over 20,000 entries,[29] and approximately 100 new titles are added each week.[30]

2. *Union Catalog of Hand-Copied Books:* This union catalog is administered by the Library of Congress, Division for the Blind, in Washington, D.C., and cata-

Organization	*Location*	*Specialty*
	MAJOR BRAILLE PUBLISHERS	
1. American Bible Society	New York City	Bibles
2. Braille Evangel, Inc.	Fort Worth, Tex.	Religious periodicals
3. Christian Record Braille Foundation, Inc.	Lincoln, Neb.	Religious periodicals
4. Christian Science Publishing Society	Boston, Mass.	Christian Science publications
5. Church of Jesus Christ of the Latter-Day Saints	Salt Lake City, Ut.	Braille books and magazines
6. Gospel Association for the Blind, Inc.	College Point, N.Y.	Religious periodicals
7. Hadley School for the Blind, Inc.	Winnetka, Ill.	Correspondence courses
8. Protestant Episcopal Church	New York City	Religious periodicals
9. Jewish Braille Institute of America, Inc.	New York City	Religious books and periodicals
10. John Milton Society	New York City	Religious literature
11. Lutheran Braille Evangelism Assoc.	Minneapolis, Minn.	Religious literature
12. Matilda Ziegler Publishing Company for the Blind, Inc.	Monsey, N.Y.	Magazines
13. National Braille Press, Inc.	Boston, Mass.	Periodicals
14. Swedenborg Foundation, Inc.	New York City	Religious literature
15. Theosophical Book Assoc. for the Blind, Inc.	Ojai, Calif.	Magazines
16. Volunteer Services for the Blind, Inc.	Philadelphia, Pa.	Books and periodicals
17. Xavier Society for the Blind	New York City	Catholic books and periodicals
	MAJOR BRAILLE PRESSES	
18. American Printing House for the Blind, Inc.	Louisville, Ky.	
19. Braille Institute of America, Inc.	Los Angeles, Calif.	
20. Clovernook Printing House for the Blind	Cincinnati, O.	
21. Howe Press of Perkins School for the Blind	Watertown, Mass.	

Exhibit 3.5. Major Braille Presses and Publishers (Sources: *Directory of Agencies Serving Blind Persons in the United States*, New York: American Foundation for the Blind, 1965; Howard Haycraft, *Books for the Blind*, Library of Congress, Division for the Blind, 1962.)

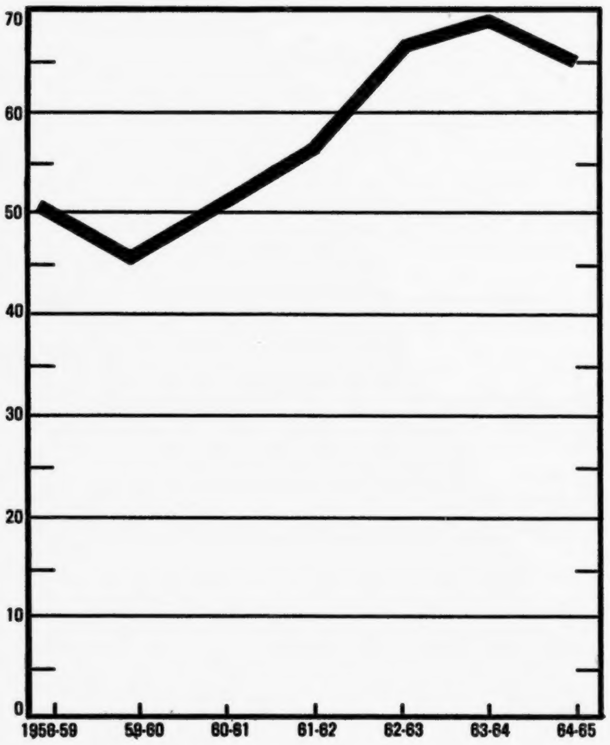

Exhibit 3.6. Millions of Press-Braille Pages Printed by the American Printing House for the Blind (Source: Annual Reports of the American Printing House for the Blind.)

logs only braille library books and general reading; no textbooks are catalogued. It is the general reading material version of the Printing House catalog and performs the same type of function. Close collaboration between the two catalogs is maintained.

3. *Central Index of Catholic Textbooks: This index* is maintained by the Xavier Society for the Blind, the national Catholic publishing house and library for the blind, which is located in New York City. The index lists braille textbooks used in diocesan school systems throughout the country.

Local braillist groups often provide information concerning books in their immediate areas or those which they have produced.[31] Service organizations may act as clearing houses for materials in their specialty such as religious or foreign-language books, and private individuals, especially blind professional people, often giving information on braille books in their particular professional field.

Library Services

A number of library facilities are available to readers of braille, although these in no way match the library facilities available to sighted readers in either size, accessibility, service, or convenience. Because of the limited mobility of blind people and the inaccessibility

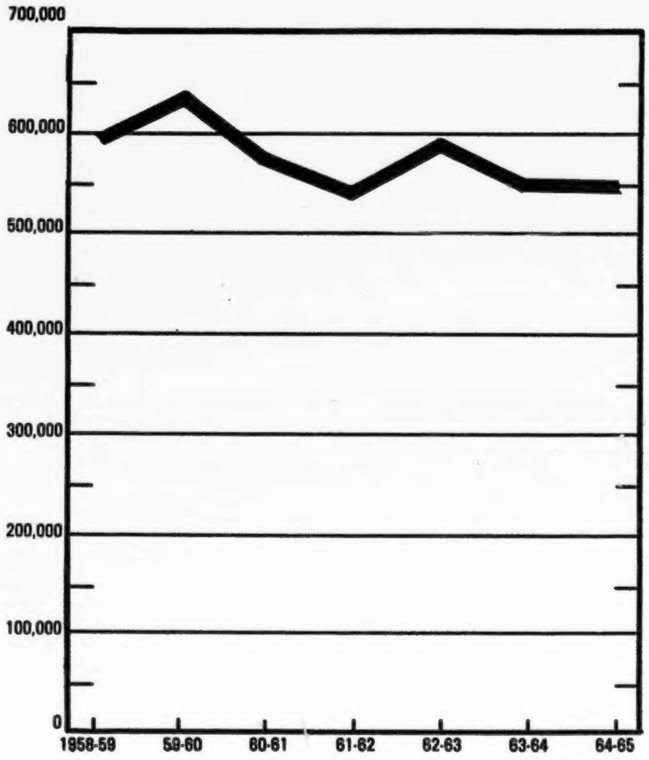

Exhibit 3.7. Number of Magazine Issues Published by the American Printing House for the Blind (Source: Annual Reports of the American Printing House for the Blind.)

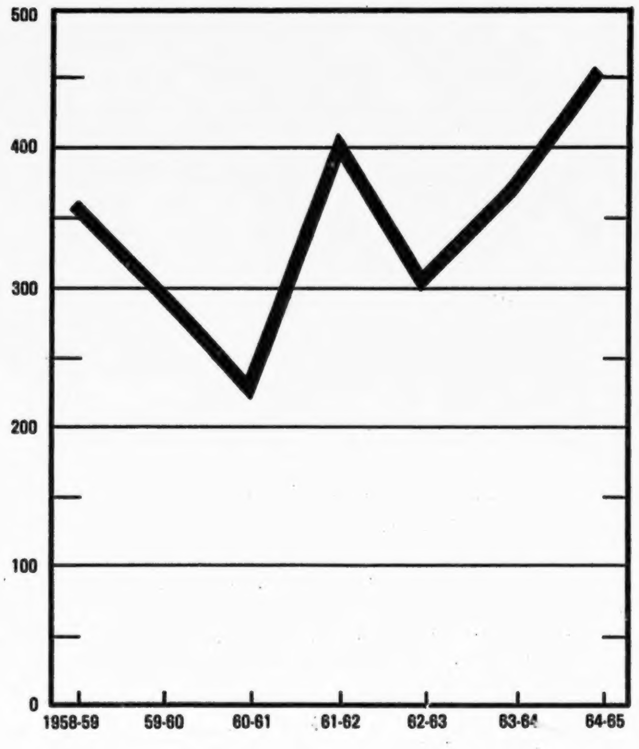

Exhibit 3.8. Number of Literary Titles Embossed in Press Braille by the American Printing House for the Blind (Source: Annual Reports of the American Printing House for the Blind.)

of most libraries, selection of books must be made either by request from published catalogs or from circulars of availability such as the *Braille Book Review* of the Library of Congress and similar circulars put out by organizations maintaining braille libraries.

Books are then ordered, usually by mail, and are distributed by mail, postage being free for braille materials. This can often be a time-consuming procedure, especially if a book is out in circulation, is in great demand, or must be obtained from another library. Exhibit 3.9 shows the location of the major libraries for the blind.

Library of Congress System

The largest and most extensive circulating-library program for braille readers is maintained by the Library of Congress, Division for the Blind. From 28 of its 32 regional libraries for the blind the library circulates braille periodicals, music scores, and books of all types except textbooks throughout the country. Exhibit 3.10 lists the names and addresses of these libraries. Reader requests are usually addressed to the nearest library.

Titles to be brailled for the Library are selected with regard to content and demand by professional librarians within the Division for the Blind assisted by advisory committees and coupled with experience factors and reader surveys.[32] The titles are then produced for the Library either by volunteers or by the braille presses and publishers. Although the Library tries to achieve quick production of current titles, the time-consuming mechanical steps involved in the assignment and production process make lapses of a year between inkprint publication and braille transcription not unusual.[33]

Exhibit 3.11 shows total contents of the Library, while Exhibit 3.12 shows the number of titles added. The total number of press braille titles now available for circulation by the Library of Congress is approximately 6,700.[34] The relatively small amount of braille library service available to the blind is readily apparent when one compares it to that available to sighted

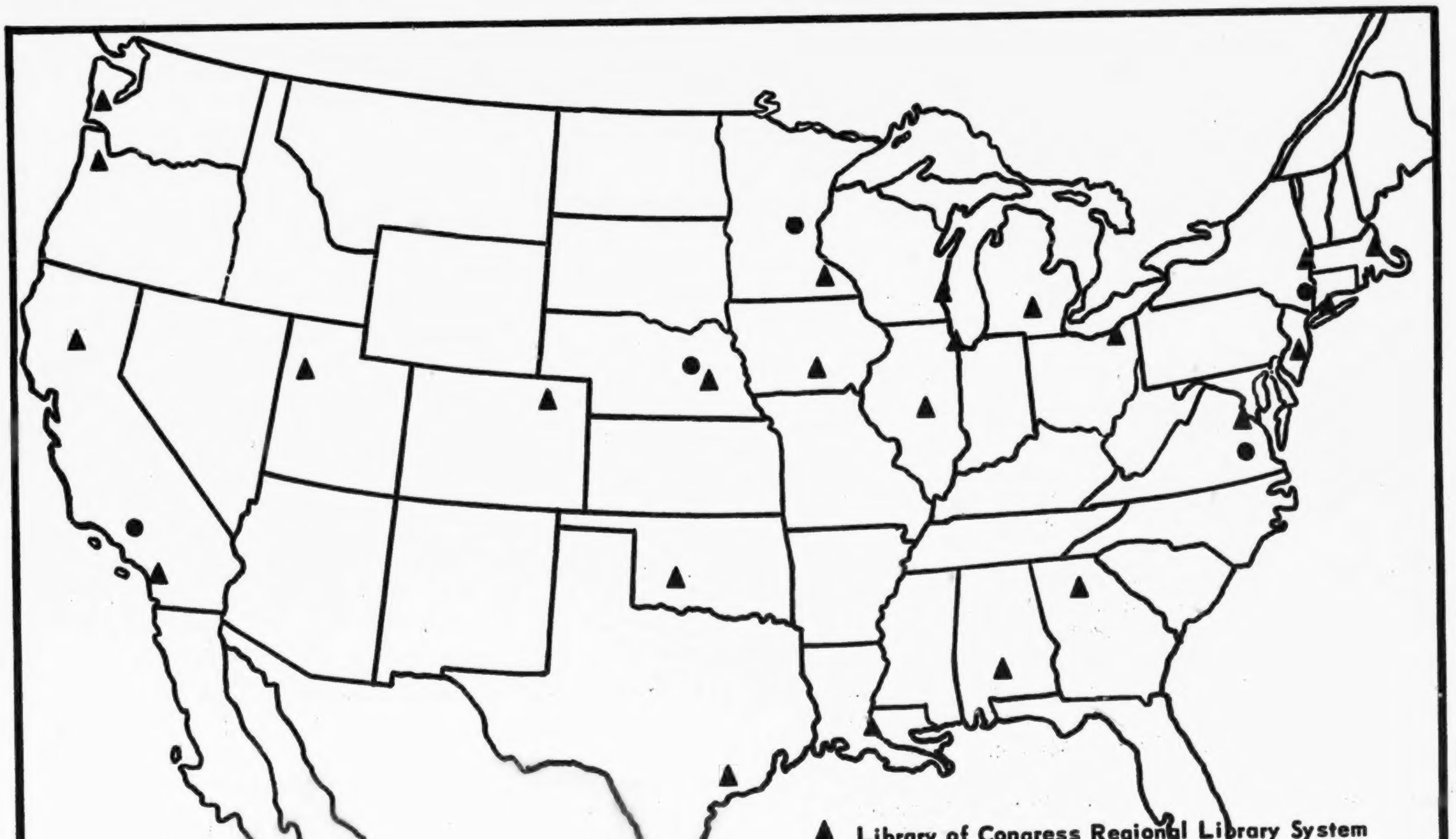
▲ Library of Congress Regional Library System (those stocking braille books)
● Service organizations (mostly religious material)
▲Hawaii

Exhibit 3.9. Braille Libraries (Sources: Library of Congress, Division for the Blind, 1965; Directory of Agencies Serving Blind Persons in the United States, New York: American Foundation for the Blind, 1965)

Alabama	Library for the Blind, Alabama Institute for Deaf and Blind, P.O. Box 455, Talladega, Alabama 35160
California	California State Library, Blind Section, Courts Building, Sacramento, California 95809
	Braille Institute of America Library 741 North Vermont Avenue, Los Angeles, California 90029
Colorado	Division of Work with the Blind, Denver Public Library, 90 Lowell Boulevard, Denver, Colorado 80219
Georgia	Library for the Blind, 1050 Murphy Avenue, S.W., Atlanta, Georgia 30310
Hawaii	Library for the Blind, 402 Kapahulu Avenue, Honolulu, Hawaii 96815
Illinois	Services to the Blind, 4544 N. Lincoln Avenue, Chicago, Illinois 60625
Indiana	Service for the Blind, Indiana State Library, 140 N. Senate Avenue, Indianapolis, Indiana 46204
Iowa	Library for the Blind, 4th and Keo Streets, Des Moines, Iowa 50309
Louisiana	Department for the Blind, Louisiana State Library, State Capitol Grounds, Baton Rouge, Louisiana 70821
Massachusetts	The Library, Perkins School for the Blind, Watertown, Massachusetts 02172
Michigan	Michigan State Library for the Blind, 735 E. Michigan Avenue, Lansing, Michigan 48913
	Department for the Blind, Wayne County Library, 33030 Van Born Road, Wayne, Michigan 48184
Minnesota	Library for the Blind, Minnesota Braille and Sight-Saving School, Faribault, Minnesota 55021
Missouri	Wolfner Library for the Blind, 3844 Olive Street, St. Louis, Missouri 63108
Nebraska	Library for the Blind, State Capitol, Lincoln, Nebraska 68509
New York	Library for the Blind, 226 Elm Street, Albany, New York 12202
	The Library for the Blind, 166 Avenue of the Americas, New York, New York 10013
Ohio	Library for the Blind, 617 College Street, Cincinnati, Ohio 45202
	Library for the Blind, 325 Superior Avenue, N.E., Cleveland, Ohio 44114
Oklahoma	Special Services Section, Oklahoma State Library, 109 State Capitol, Oklahoma City, Oklahoma 73105
Oregon	Books for the Blind, 215 N.E. Knott Street, Portland, Oregon 97212
Pennsylvania	Library for the Blind, 17th and Spring Garsen Streets, Philadelphia, Pennsylvania 19130
Texas	Texas State Library, State Capitol, Austin, Texas 78711
Utah	Division for the Blind, Utah State Library, 1488 S. State Street, Salt Lake City, Utah 84115
Virginia	Virginia State Library for the Blind, 3003 Parkwood Avenue, Richmond, Virginia 23221
Washington	Library for the Blind, 425 Harvard Avenue, N., Seattle, Washington 98102
Wisconsin	Library for the Blind, Milwaukee Public Library, 814 W. Wisconsin, Milwaukee, Wisconsin 53233

Exhibit 3.10. Regional Libraries of the Library of Congress, Division for the Blind (those handling braille books)

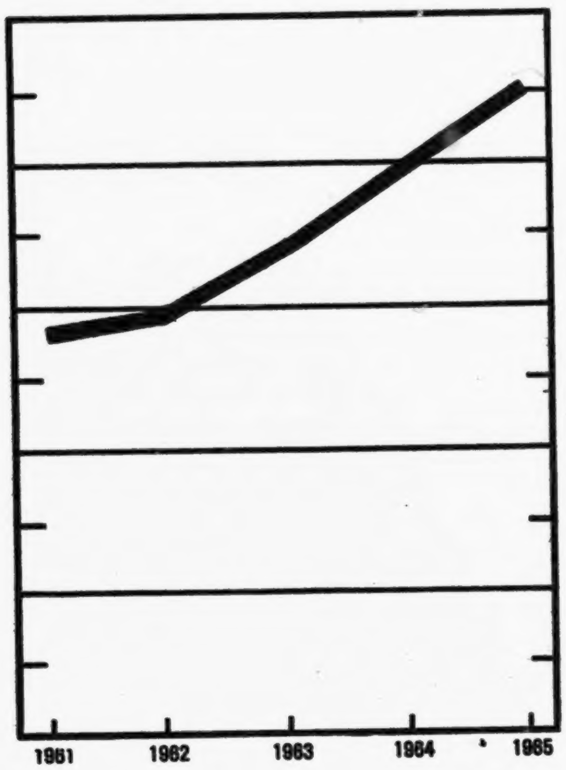

Exhibit 3.11. Total Library of Congress Holdings of Raised Character Books for the Blind (Source: Annual Reports of the Librarian of Congress.)

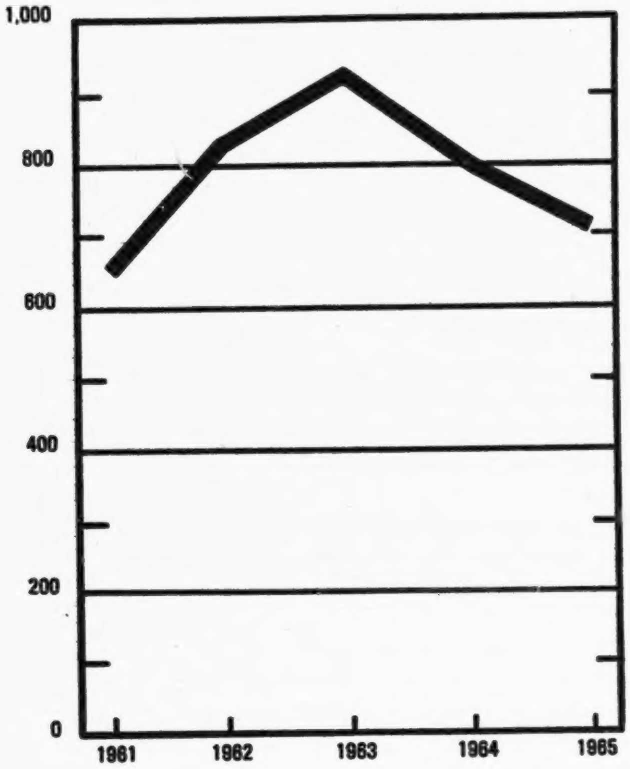

Exhibit 3.12. New Titles Added to the Library of Congress Braille Collection (Source: Annual Reports of the Librarian of Congress.)

readers. In 1950 the United States had 6,028 public libraries with an aggregate of 142,931,000 volumes.[35] Yet in 1964 there were only 28 public libraries for braille readers with an aggregate of 786,396 volumes in braille.[36] (Many titles are available to the blind on tapes and talking-book records. Also, one title may encompass several volumes.)

Braille circulating libraries are maintained on a much smaller scale by blind service organizations and braille publishers, most of which offer material in their own specialty, mainly religious and educational material. Twelve organizations, some of which are listed in Exhibit 3.5, offer such a service.[37] Also many states maintain braille book depositories of educational textbooks as part of their state education departments or divisions for the blind. These are primarily for textbooks used by the blind in the states' school systems. In addition, some individuals, especially those in the professions, offer library-type service from their private collections of braille professional material. Even when one includes private braille collections in residential schools, homes for the blind, lighthouses and allied organizations, and places where braille is taught, only about 100 more braille collections of varying size, content, quality, and availability exist for the blind reader.

REFERENCES

1. Reference for this section comes from Thomas A. Bledsoe, "General Catalog of Volunteer-Produced Textbooks at the American Printing House for the Blind," *International Journal for the Education of the Blind*, October, 1962.
2. *Ibid.*
3. *Ibid.*
4. Krebs, Bernard M. "A Braillist Talks with Resource Teachers," *The New Outlook for the Blind*, April, 1959, p. 134.
5. Personal interview with Harry Friedman, Manager, The Howe Press of the Perkins School for the Blind, Watertown, Massachusetts, March 8, 1965.
6. Personal letter from Miss Ruth L. Keyes, Head, Volunteer Services Section, Division for the Blind, Library of Congress, Washington, D.C., June 6, 1966.
7. *Ibid.*
8. Personal interview with Mrs. Thetis Nyitray, National Braille Press, Boston, Massachusetts, March 12, 1965.
9. Braille Circular No. 64-5, Library of Congress, Division for the Blind, November 2, 1964.
10. Telephone interview with Mrs. Merrill Maynard, certified proofreader, Taunton, Massachusetts, August 22, 1965.
11. Personal interview with Mrs. Thetis Nyitray.
12. Personal interview with Mrs. Vera Clark, National Braille Association, New York City, March 29, 1965.

13. Blesdoe. "General Catalog of Volunteer-Produced Textbooks at the American Printing House for the Blind," *op. cit.*
14. Mann, Robert W. "Enhancing the Availability of Braille," in *Proceedings of the International Congress on Technology and Blindness.* Vol. I. New York: American Foundation for the Blind, 1963, p. 413.
15. Based on production records listed in *Ninety-seventh Report of the Board of Trustees.* American Printing House for the Blind, Louisville, Kentucky, for the year ending June 30, 1965, p. 23.
16. Mann. "Enhancing the Availability of Braille," *op. cit.*
17. *The World Almanac and Book of Facts.* New York: New York World Telegram and the Sun, 1966, p. 512.
18. Mann. "Enhancing the Availability of Braille," *op. cit.*
19. *Ibid.*
20. Based on production records listed in the Annual Reports of the American Printing House for the Blind.
21. Based on *Directory of Agencies Serving Blind Persons in the United States.* New York: American Foundation for the Blind, 1965, List F; and *General Catalog of Braille Publications, 1966.* Louisville, Ky: American Printing House for the Blind, 1966, pp. 157-160.
22. *The Standard Periodical Directory.* 1st ed., New York: Oxbridge Publishing Company, 1964, page v.
23. Based on *Ninety-seventh Report of the Board Trustees, op. cit.*, and Mann, "Enhancing the Availability of Braille," *op. cit.*
24. Dabney, William C. *American Printing House for the Blind, Inc.* New York: The Newcomen Society in North American, 1960, p. 19.
25. *Directory of Agencies Serving Blind Persons in the United States, op. cit.*, p. 211.
26. Personal letter from Donald W. Reed, Executive Director, Clovernook Home and School for the Blind, Cincinnati, Ohio, May 27, 1966.
27. *Volunteers Who Produce Books.* Washington, D.C.: Division for the Blind, Library of Congress, May, 1965, and supplement November, 1965.
28. *Directory of Agencies Serving Blind Persons in the United States, op. cit.*, p. 212.
29. Personal interview with Carl Lappin, Textbook Consultant, American Printing House for the Blind, Louisville, Kentucky, April 19, 1965.
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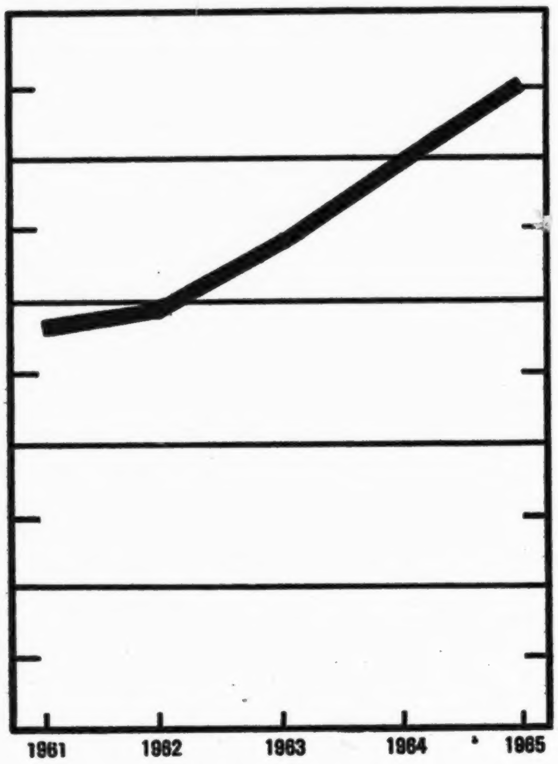
31. *Ibid.*
32. Haycraft. *Books for the Blind, op. cit.*, p. 6.
33. *Ibid.*
34. *Ibid.*, p. 4 and Exhibit 3.12.
35. *The Standard Periodical Directory, op. cit.*
36. *Annual Report of the Librarian of Congress* for the Fiscal Year ending June 30, 1964, Washington, D.C.: Library of Congress, 1965.
37. Gallozzi, Charles. "Location of Copies, Numbers of Borrowers, and Distribution," address in *Conference on Volunteer Activities in Recording and Transcribing Books for the Blind, Proceedings.* Washington, D.C.: Library of Congress, 1954, p. 47.
38. *Ibid.*



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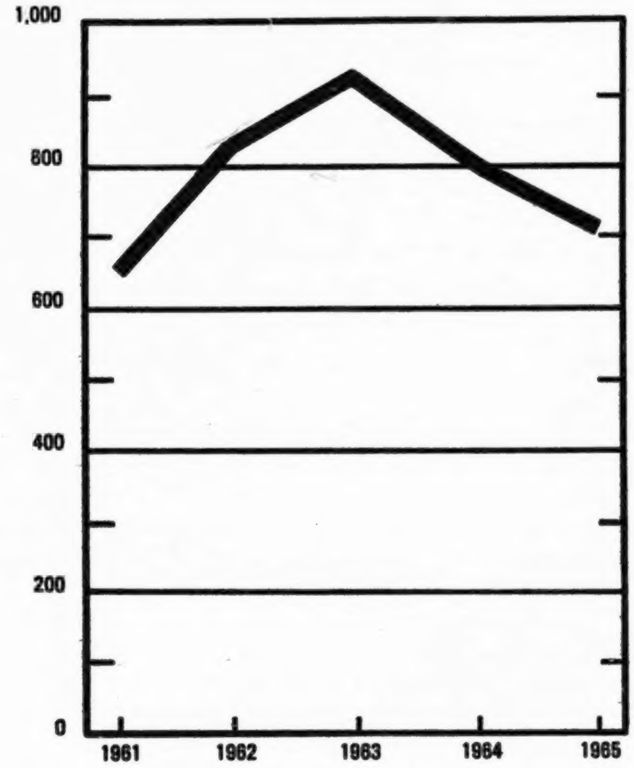

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3. *Ibid.*
4. Krebs, Bernard M. "A Braillist Talks with Resource Teachers," *The New Outlook for the Blind*, April, 1959, p. 134.
5. Personal interview with Harry Friedman, Manager, The Howe Press of the Perkins School for the Blind, Watertown, Massachusetts, March 8, 1965.
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7. *Ibid.*
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33. *Ibid.*
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37. Gallozzi, Charles. "Location of Copies, Numbers of Borrowers, and Distribution," address in *Conference on Volunteer Activities in Recording and Transcribing Books for the Blind, Proceedings*. Washington, D.C.: Library of Congress, 1954, p. 47.
38. *Ibid.*

Chapter 4

The Present Methods and Costs of Producing Braille

PRODUCTION AND DISTRIBUTION SYSTEM

The braille production and distribution system and its environment can be visualized as shown in Exhibit 4.1. For simplicity it can be divided into three elements: input, production, and distribution. These, in turn, are activated by a fourth element, the braille readers.

The input element transforms the reader request or market demand into a form suitable for transcription into braille. For example, in the present braille production system the input function may be performed by a braillist group chairman who receives the request, clears it, obtains the book to be brailled, and assigns it to a braillist. On the other hand, it may be a braille editor who determines the demand for a book and decides whether it should be produced in press braille.

The production element transforms inkprint into braille. In braillist groups this function is performed by the transcriber. In braille presses the combined effort of transcriber and press department performs the function.

The distribution element disseminates the brailled material from the producer to the braille reader. This function is presently carried out by braille libraries, braille presses and publishers, and braillist groups.

All these functions take place in an environment of social, political, and economic factors.

PRESENT PRODUCTION METHODS

At present, practically all braille produced from inkprint copy, whether hand copy or press braille, is hand-transcribed by trained braillists, a time-consuming process. Practically all braille is embossed and bound in standard-size volumes and shipped to the library, agency, or individual requesting it. The methods and procedures have been used for over a half a century. The input, production, and distribution elements consist of a number of steps, depending upon the method of production used.

The present methods of producing braille can be classified into three categories: (*1*) hand transcribed braille; (*2*) press braille; (*3*) duplicated braille.

Hand-Transcribed Braille

Hand-transcribed braille refers to single-copy braille material embossed directly onto braille paper, usually by a volunteer braillist. The procedure followed in producing hand-transcribed material and the approximate time and costs incurred are shown graphically in Exhibit 4.2.

Input

1. *Request:* The hand-transcribing process may be started by a request for a particular book sent by a blind individual to a braillist group. The request may come from a board of education or from the Library of Congress. The request may be routine: a blind reader desires some recreational or professional reading. Or it may be urgent: a blind college student has finally been informed at the end of August about the textbooks he will be needing by mid-September.

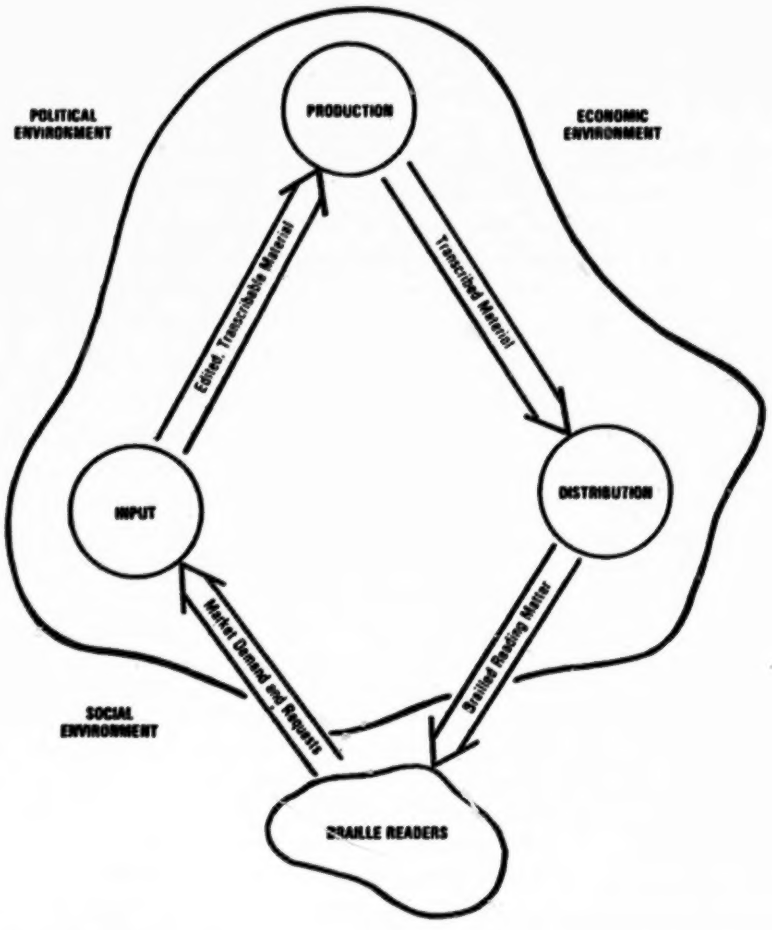
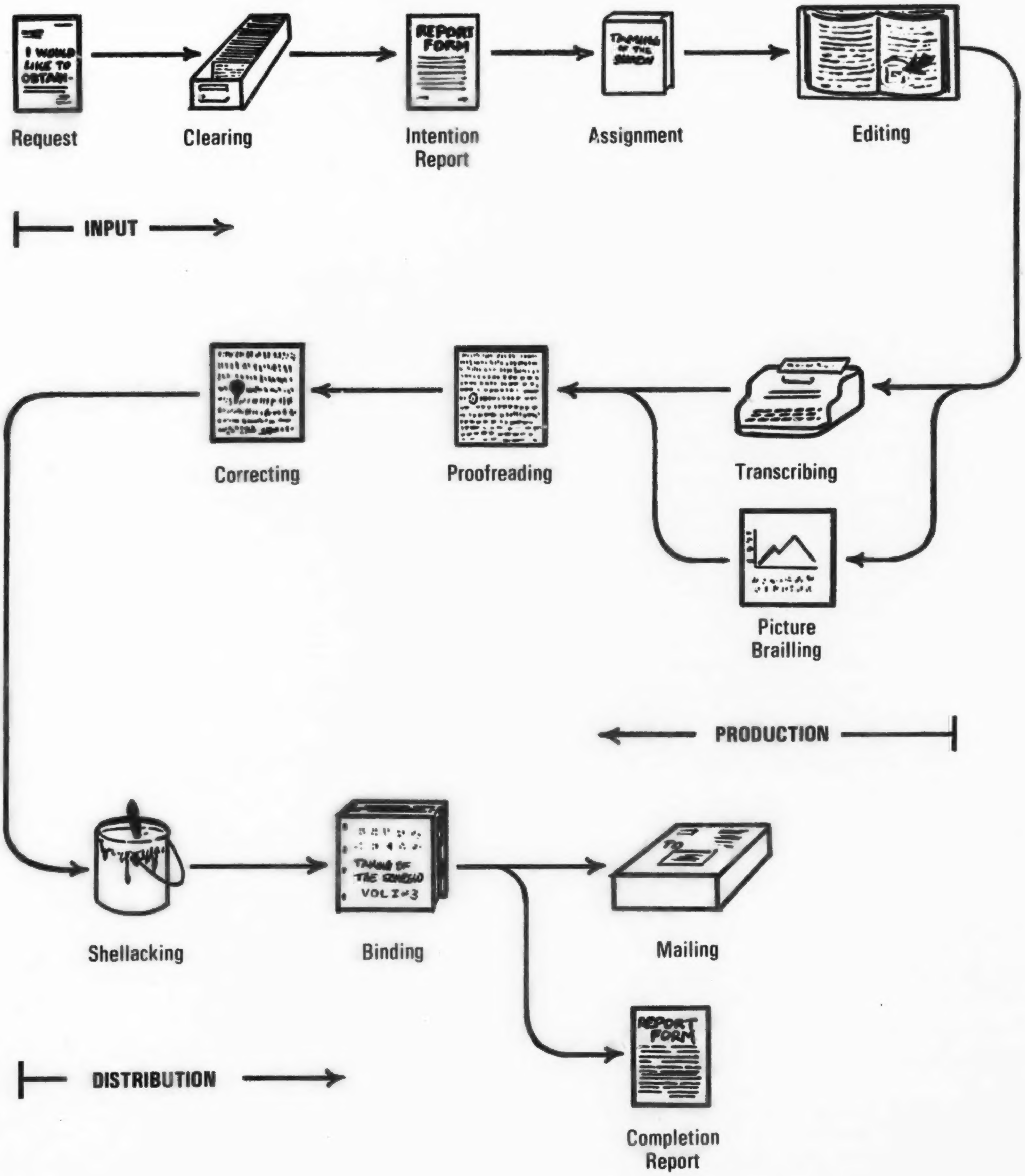


Exhibit 4.1. Model of the Braille Production and Distribution System

2. *Clearing:*[1] To have spent hundreds of hours transcribing a braille book only to find out later that a copy had been available elsewhere is a wasteful and heartbreaking situation. Therefore, all requests must be cleared before brailling is undertaken.

The first step is to check the catalogs of the various braille presses and publishers and those of braille libraries. Often the requested book may be available for sale, but a blind student, parent, or reader wishes to avoid paying for it by requesting a volunteer-produced copy. This is a waste of time and material.[2]

Should the book not be available from these sources, the braillist group then inquires of the *General Catalog of Volunteer-Produced Textbooks* at the American Printing House for the Blind. This clearing house keeps records not only of braille textbooks completed but also of all books in the process of being brailled. The group also checks with the other clearing houses: the *Union Catalog of Hand-Copied Books* at the Library of Congress, the *Central Index of Catholic Textbooks*, and similar organizations. These inquiries usually receive immediate attention. If the title is available in braille form, the clearing house gives the name and address of the place where it can be obtained. If the


I WOULD LIKE TO OBTAIN-
Request
Clearing
REPORT FORM
Intention Report
TAMING OF THE SHREW
Assignment
Editing
INPUT
Correcting
Proofreading
Transcribing
Picture Brailling
PRODUCTION
Shellacking
TAMING OF THE SHREW VOL I-3
Binding
TO
Mailing
REPORT FORM
Completion Report
DISTRIBUTION

Approximate total time: 100 man hours per average title (5 volumes)
Approximate total cost: $7.50 (materials)

Exhibit 4.2. The Process of Producing Hand-Transcribed Braille Books (Source: See text.)

title is in the process of being brailled, the name and address of the group doing the brailling is given. The requesting group can then contact the source given or pass on the information to the original requester.

An example of a contact form, mentioning the various circumstances for obtaining books, is given in Exhibit 4.3. Exhibit 4.4 is a typical reply form listing the possible results of a request.

If no copies are available or if, under special circumstances, a group desires to have its own copy of a book, permission to braille is granted. If the group decides to transcribe the requested book, an Intention Report, shown in Exhibit 4.5, is filed with the General Catalog at the Printing House. Most textbook publishers and many general publishers have given blanket permission for copies of their books to be brailled without payment of copyright royalties. Indication of permission is listed on the form.

Although many books are transcribed which, for various reasons, are never reported to the clearing houses, these clearing organizations make every attempt to be as complete as possible. The cooperation of individual braillists and braillist groups is, therefore, imperative.[3]

3. *Assignment:* Work to be brailled is assigned by the group coordinator to a member braillist to be transcribed. If the work involves a braille speciality such as music, a foreign language, or mathematics, a braillist knowing the specialty is given the job. Ordinary brailling is usually assigned to whoever is available.

Ideally, an inkprint text should reach the volunteer from four to six months before the braille copy is needed. However, where a transcription is needed on very short notice, as is often the case with last-minute textbook selections, or if the work is very long, the coordinator may divide the work among a number of braillists or may engage supplemental or, sometimes, paid braillist help.[4]

4. *Editing:* Before beginning to transcribe, the braillist or the coordinator must edit the inkprint material so that it is in the most meaningful and compact format for the blind reader. Depending on the type of material and its purpose, sections can often be condensed or eliminated. If there are pictures, figures, or diagrams in the text, the braillist must then decide whether to eliminate them entirely, substitute a written description, or emboss the figures as line drawings.

Production

5. *Transcribing:* The process of transcribing consists of reading the inkprint text and embossing the braille equivalent on braille paper. "Longhand" braille is produced by clamping braille paper in a braille slate and embossing the appropriate bumps with a stencil and stylus. The device and its cost are shown in Exhibit 4.6. These devices are used mainly for short work, training, and note-taking.

The majority of transcribing is done on mechanical braillewriters. These devices are essentially braille typewriters. By pressing the appropriate keys, a braille cell is embossed. The most widely used braillewriter is the Perkins Brailler shown in Exhibit 4.7. This is a high-quality, rugged machine in use throughout the world. As of 1965 there were 28,000 Perkins Braillers in use.[5] For less demanding use, student use, and training purposes, the Hall and Lavender Braillewriters, similar in operation to the Perkins but less expensive, are available. Their costs are also given in Exhibit 4.7.

A good braillist using a mechanical braillewriter completes an average of one braille page of straight prose every 12 to 15 minutes. A good typist could type the same number of words in inkprint in approximately four minutes. An average book with 100 pages per volume and five volumes per book requires 100 hours brailling time.[6] If errors occur in brailling—and because of the nature of the process they occur frequently—the errors must be burnished flat with a "braille eraser" and then reembossed. This is tedious and time consuming.

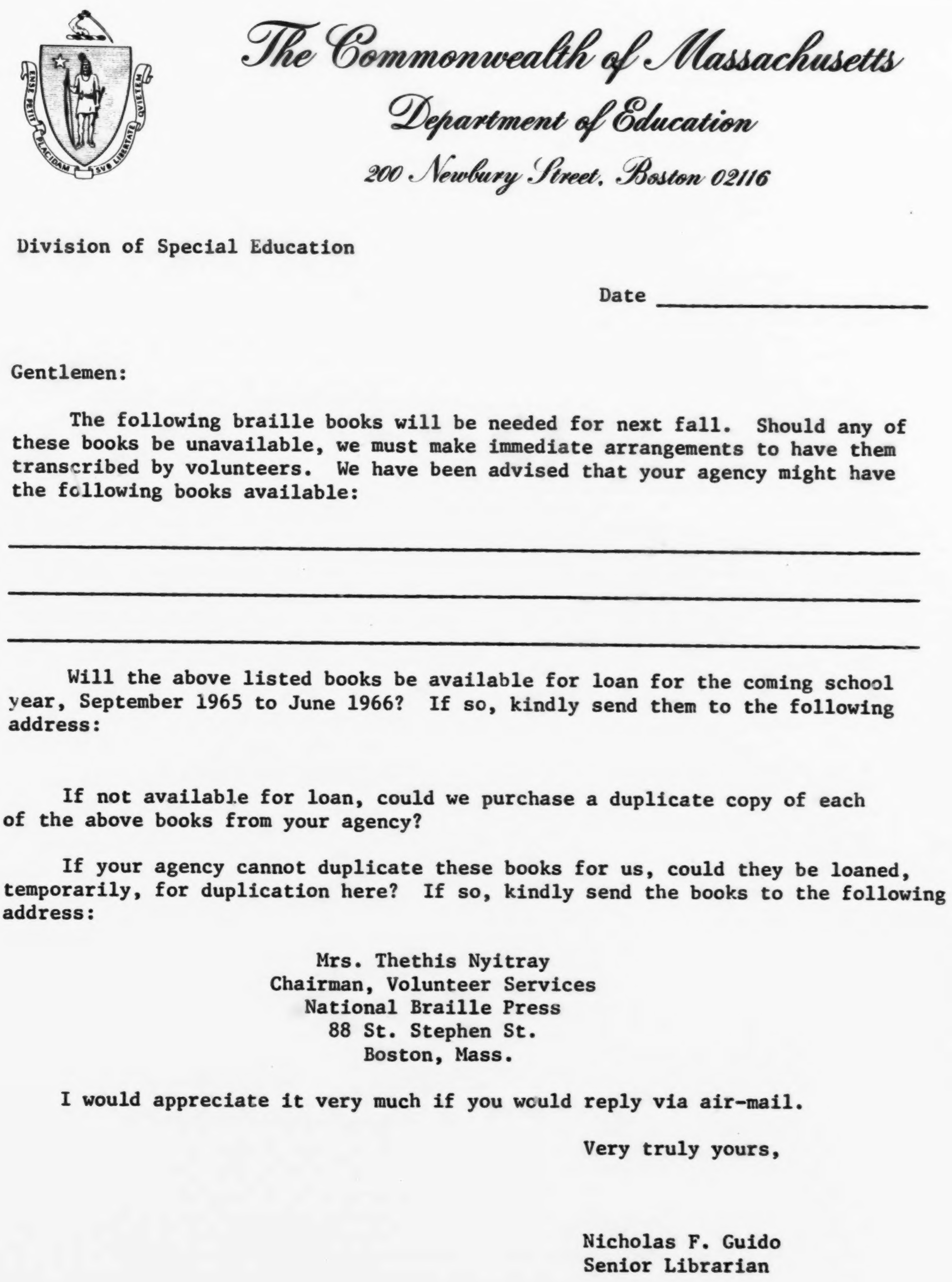
For specialized codes and pages requiring tables, pictures, or nonstandard formats, brailling time is increased. Music, for example, can be brailled at only about two pages per hour.[7]

6. *Picture Brailling:* In some instances it is desirable or even imperative for the blind reader to have a tactual representation of a visual image, picture, or geometrical configuration. Here the braillist must use great discretion in deciding how best to convey the idea without making the representation overly complex. Some artistic talent is also needed here.

When the braillist has decided how she will portray the image, she lays it out in pencil on the braille paper. Then, using star wheels for dot embossing and special rulers for line embossing, she produces the embossed image. As does any artistic work, picture brailling requires great amounts of time and patience.

7. *Proofreading:* School textbooks, master braille copies from which duplicates will be made, and books transcribed for the Library of Congress must be proofread before they are submitted as complete. Proofreading is done by certified proofreaders to whom the books are sent. The cost of this service ranges from five to twelve cents per page depending on the type of material being read.[8] The Library of Congress is presently paying ten cents per page for proofreading, and this is the most common rate.[9]

The proofreader is most usually a blind person, one who is extremely familiar with the rules and format of braille and who is usually a braillist also. The proofreader reads the braille manuscript noting errors as he or she reads. In places where the proofreader is in doubt as to the content of the transcription or where the omission of material is suspected, a sighted person is usually asked to consult the inkprint manuscript which is sent along with the braille copy.

The Commonwealth of Massachusetts
Department of Education
200 Newbury Street, Boston 02116

Division of Special Education

Date ____________________

Gentlemen:

The following braille books will be needed for next fall. Should any of these books be unavailable, we must make immediate arrangements to have them transcribed by volunteers. We have been advised that your agency might have the following books available:

____

____

____

Will the above listed books be available for loan for the coming school year, September 1965 to June 1966? If so, kindly send them to the following address:

If not available for loan, could we purchase a duplicate copy of each of the above books from your agency?

If your agency cannot duplicate these books for us, could they be loaned, temporarily, for duplication here? If so, kindly send the books to the following address:

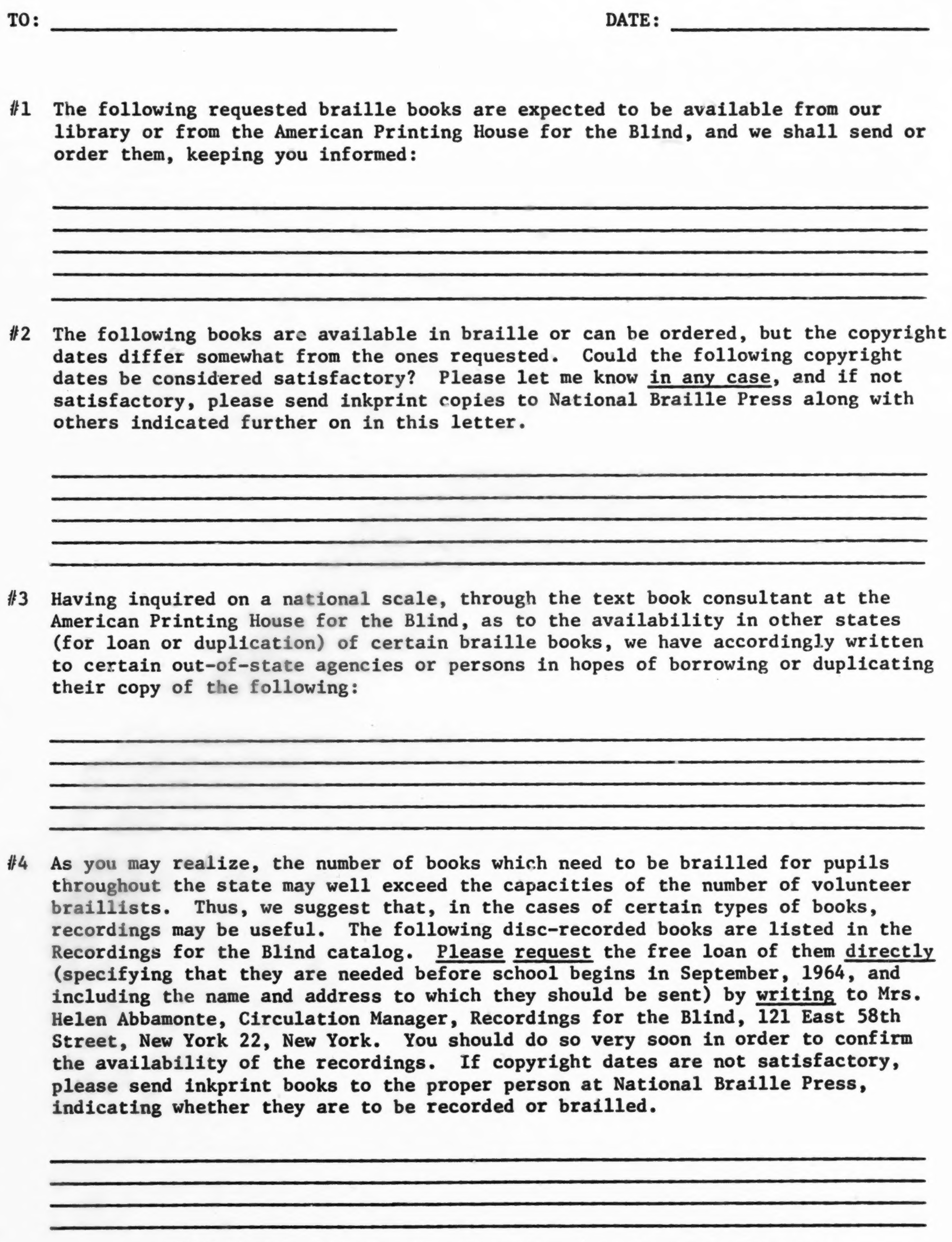
Mrs. Thethis Nyitray
Chairman, Volunteer Services
National Braille Press
88 St. Stephen St.
Boston, Mass.

I would appreciate it very much if you would reply via air-mail.

Very truly yours,

Nicholas F. Guido
Senior Librarian

Exhibit 4.3. Representative Loan Request Form.



TO: ______________________________ DATE: ______________________

#1 The following requested braille books are expected to be available from our library or from the American Printing House for the Blind, and we shall send or order them, keeping you informed:

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____
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#2 The following books are available in braille or can be ordered, but the copyright dates differ somewhat from the ones requested. Could the following copyright dates be considered satisfactory? Please let me know in any case, and if not satisfactory, please send inkprint copies to National Braille Press along with others indicated further on in this letter.

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____
____
____

#3 Having inquired on a national scale, through the text book consultant at the American Printing House for the Blind, as to the availability in other states (for loan or duplication) of certain braille books, we have accordingly written to certain out-of-state agencies or persons in hopes of borrowing or duplicating their copy of the following:

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____
____
____

#4 As you may realize, the number of books which need to be brailled for pupils throughout the state may well exceed the capacities of the number of volunteer braillists. Thus, we suggest that, in the cases of certain types of books, recordings may be useful. The following disc-recorded books are listed in the Recordings for the Blind catalog. Please request the free loan of them directly (specifying that they are needed before school begins in September, 1964, and including the name and address to which they should be sent) by writing to Mrs. Helen Abbamonte, Circulation Manager, Recordings for the Blind, 121 East 58th Street, New York 22, New York. You should do so very soon in order to confirm the availability of the recordings. If copyright dates are not satisfactory, please send inkprint books to the proper person at National Braille Press, indicating whether they are to be recorded or brailled.

____
____
____
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Exhibit 4.4. Representative Reply Form (Source: Massachusetts Department of Education.)

#5 We have not found the following books to be available in braille. Therefore, kindly send immediately to Mrs. Thethis Nyitray, Chairman of Volunteer Services, National Braille Press, 88 Saint Stephen Street, Boston, Mass., those of the following inkprint texts you wish brailled, with a covering letter (very important) listing the books in order of preference and specifying that you request them to be brailled and sent to the address you give. If pages of any book are to be omitted, please mention this fact. If books are lengthy, please send two copies, or indicate that they may be split. Books must be in good condition. Those of the following books which you wish to be recorded (if not available from Recording for the Blind) please send to Mrs. Frances Patterson, National Braille Press, also with a covering letter and specifying whether they are to be recorded on Tapes or Soundscriber Discs.

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____

#6 If substitute braille books will be helpful, please contact me.

#7 Mathematics books are most difficult to obtain in braille, since a specialized skill is required in transcribing them, and there are not sufficient volunteers who have this skill. We shall try to keep you informed on this matter.

#8 Some of your requested books may arrive during this school year.

Thank you for your cooperation.

Very truly yours,

Nicholas F. Guido
Senior Librarian

Exhibit 4.4. Representative Reply Form (cont.)

For APH use only

Advised of previous transcription

____
date

American Printing House for the Blind

INCORPORATED
P. O. Box 6085
1839 Frankfort Avenue, Louisville, Ky. 40206
Telephone: 502-895-2405

Report of
INTENTION
Title
(Send to APH)

REPORT FORM FOR CENTRAL CATALOG OF VOLUNTEER-PRODUCED BOOKS

BRAILLE

Book Title _______________ (Give grade level if part of name in a textbook series) Edition _______________ (If given in title)

Series Name (if textbook) _______________ School Grade: _______________

Author(s) _______________ (List all names, last name first, and separated from each other by semicolons)

____

Ink-print Publisher _______________ (Include also city and state of publisher's address)

Copyright Dates _______________ (List all dates in same order as found in copyright)

Permission to Reproduce: Blanket Agreements: ATPI _______________ AAUP _______________ CBC _______________ Obtained by Transcriber or Tr. Agency _______________ Report Date of Intention to Copy _______________

Name and Address of Transcribing Group _______________

____

Name of Transcriber _______________ Address of Transcriber _______________

Certified by Library of Congress? Yes ______ No ______ When _______________

* * *

Grade of Braille _______________ Style of Embossing _______________ (One-side; one-side every other line; interlined) Written on Braillewriter ( ) Or Slate ( )

No. of Volumes ______ No. of pages per volume _______________ (By individual volumes) Total Pages _______________

Multiple-copy Edition _______________ Single-copy Edition _______________ Can you provide Thermoform copies? _______________

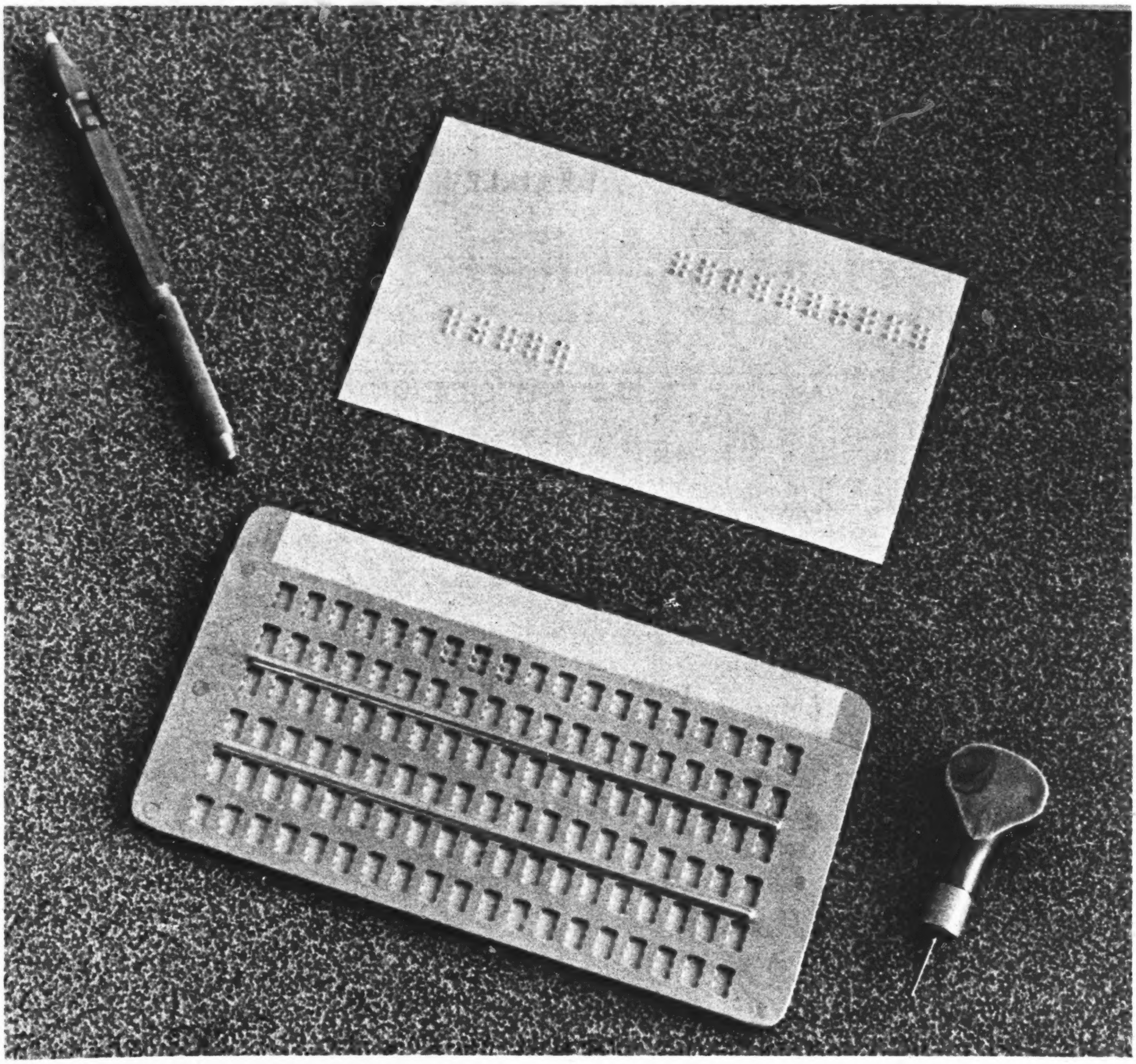
Copies for Sale? _______________ For Rent? _______________ For Loan? _______________

Page Size _______________ Name of Proofreader _______________ Year Transcribed _______________ "Completion" Report Date _______________

Proofreader Certified by Library of Congress? Yes ______ No ______ When _______________

Name and Address of Depository for Title _______________

Exhibit 4.5. Intention Report (filled out up to asterisks)



Unit cost: $4.10
Paper cost: $3.00 per ream

for 8 1/2" x 11" paper (not shown)

Exhibit 4.6. Braille Slate, Stencil, and Stylus (Price Source: American Printing House for the Blind.)

A good proofreader covers about fifteen pages per hour, and the numbers of mistakes found usually vary with the skill of the transcribing braillists. Proficient braillists average fewer than one error per page.[10]

8. *Correcting:* Upon return of the manuscript from the proofreader, the braillist must "erase" errors by burnishing them flat with a "braille eraser" and remboss the cells in error.

9. *Shellacking:* Many paper manuscripts are lightly brushed with shellac before binding to harden the paper somewhat. In this way the manuscript becomes more durable because the constant pressure of fingers passing over the braille bumps during reading will have less of a tendency to flatten out the bumps.

10. *Binding:* After shellacking, the braille manuscript is bound into volumes averaging 100 pages per volume. Costs for binding in soft cardboard covers for personal books range from about 50 to 75 cents per volume, whereas hard covers for library and textbook use cost about $3.00.[11,12]

Distribution

11. *Completion Report:* As soon as the transcription is completed, a Completion Report, shown in Exhibit 4.8, is filed with the Central Catalog at the American Printing House. The Printing House then sees that the information is appropriately listed either in the *Central Textbook Catalog* or with the *Union Catalog* at the Library of Congress. A report is also sent to the National Braille Association so that the transcriber will receive credit for her work.[13]

12. *Mailing:* Material for the blind is mailed postage free, the only charge being for insurance, if desired.

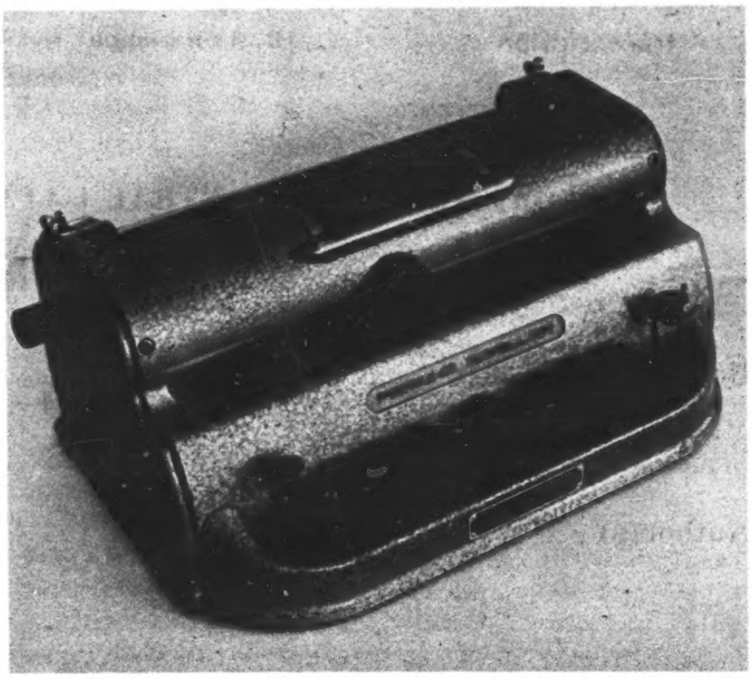
Press Braille

Multiple copies of books, usually of books with a total demand of about thirty or more copies,[14] are usually transcribed for press braille, braille that is produced from zinc master plates on embossing presses. The procedure, time, and costs involved are shown in Exhibit 4.9. Those procedures which are different from the ones involved in hand-copied brailling are covered below.

Input

1. *Publishers and Popular Book Lists:* The initial selection of inkprint books to be considered for press braille editions are picked with many of the same criteria as are books for public libraries[15] or textbooks for public schools.

Previous to the publication of new stocks of textbooks, the textbook consultant of the American Printing House for the Blind queries publishers as to those that appear to have the greatest expectations for adoption by schools.[16] The Library of Congress and the Printing House use standard book review media, preview media, and popularity criteria to select popular books for consideration.[17]



Unit cost:	**Perkins Brailler $90.00** **Hall Braillewriter $65.00** **Lavender Braillewriter $45.00**
Paper cost:	**$3.00 per ream**

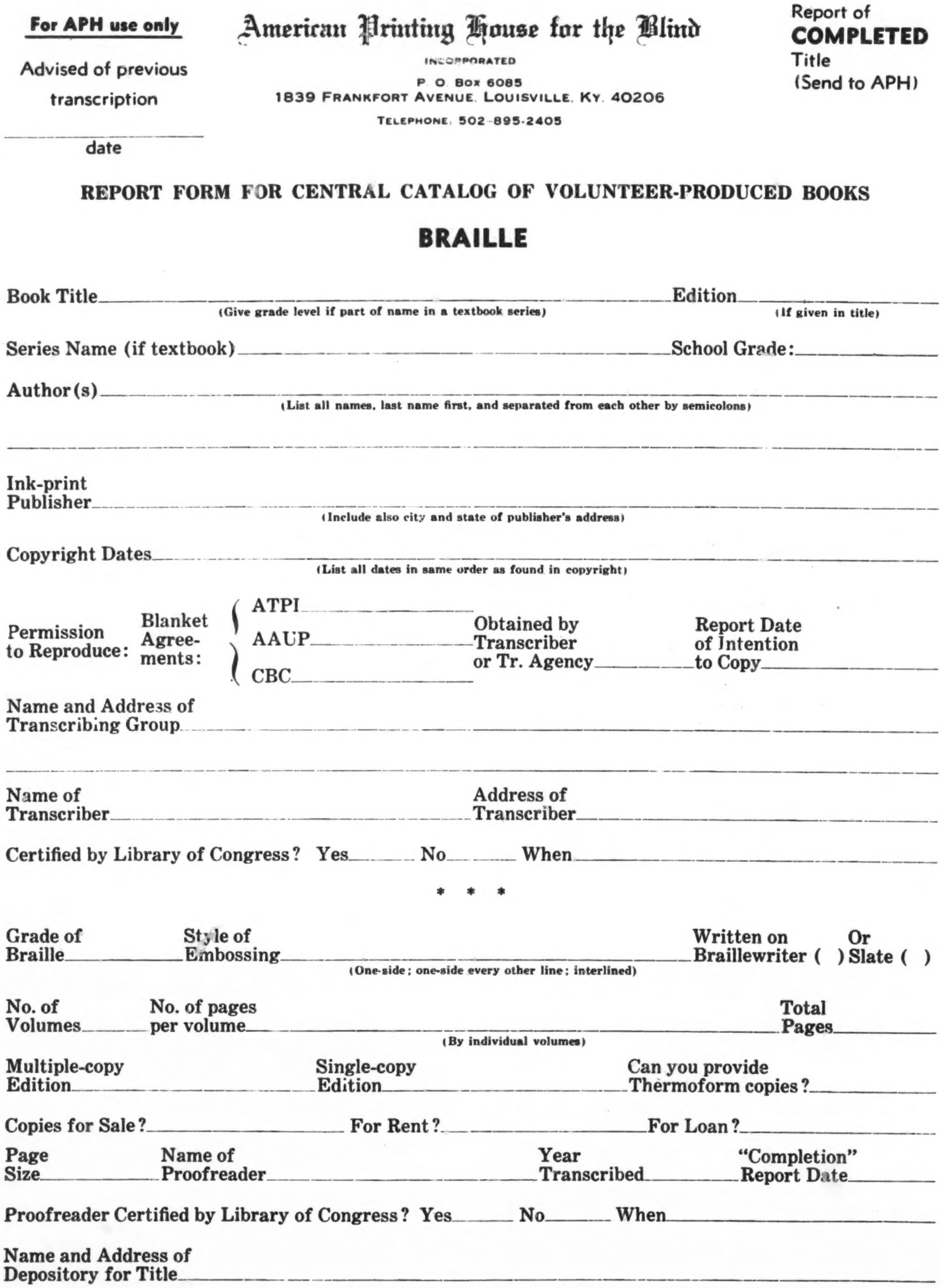
Exhibit 4.7. The Perkins Brailler (Price Source: American Printing House for the Blind.)

2. *Selection Committee:* Books chosen for consideration are then sent to selection committees which pass on their adoption. The Printing House committee includes the braille editor and other braille textbook consultants. The Library of Congress committees include professional staff librarians assisted by blind and sighted advisory groups and by reader comments.[18]

3. *Editor's Estimates:* The size of the press run to be made is based on estimates of demand, popularity, and similar factors. At the Printing House the braille editor determines these figures. Too small a run means long waits and disappointment to many readers, while too large a run means wasted time, material, and inventory space.

4. *Stereographing:* The transcribing of the braille copy is done in a manner similar to that involved in hand-copying braille. A skilled braillist using a braillewriting machine embosses a braille copy.

In this case, however, the braillist uses a stereograph machine which has the same keyboard as does the manual braillewriter but which is a much larger machine and which embosses zinc plates for press masters. The masters are interpointed, allowing braille to be embossed on both sides of a page. A manual stereograph machine costs about $4,000.[19]



For APH use only

Advised of previous transcription

____
date

American Printing House for the Blind

INCORPORATED
P. O. Box 6085
1839 Frankfort Avenue, Louisville, Ky. 40206
Telephone: 502-895-2405

Report of
COMPLETED
Title
(Send to APH)

REPORT FORM FOR CENTRAL CATALOG OF VOLUNTEER-PRODUCED BOOKS

BRAILLE

Book Title_______________ Edition_______________
(Give grade level if part of name in a textbook series) (If given in title)

Series Name (if textbook)_______________ School Grade:_______________

Author(s)_______________
(List all names, last name first, and separated from each other by semicolons)

____

Ink-print Publisher_______________
(Include also city and state of publisher's address)

Copyright Dates_______________
(List all dates in same order as found in copyright)

Permission to Reproduce: Blanket Agreements: ATPI_______________ AAUP_______________ CBC_______________ Obtained by Transcriber or Tr. Agency_______________ Report Date of Intention to Copy_______________

Name and Address of Transcribing Group_______________

____

Name of Transcriber_______________ Address of Transcriber_______________

Certified by Library of Congress? Yes_____ No_____ When_______________

* * *

Grade of Braille_______________ Style of Embossing_______________ Written on Braillewriter ( ) Or Slate ( )
(One-side; one-side every other line; interlined)

No. of Volumes_______________ No. of pages per volume_______________ Total Pages_______________
(By individual volumes)

Multiple-copy Edition_______________ Single-copy Edition_______________ Can you provide Thermoform copies?_______________

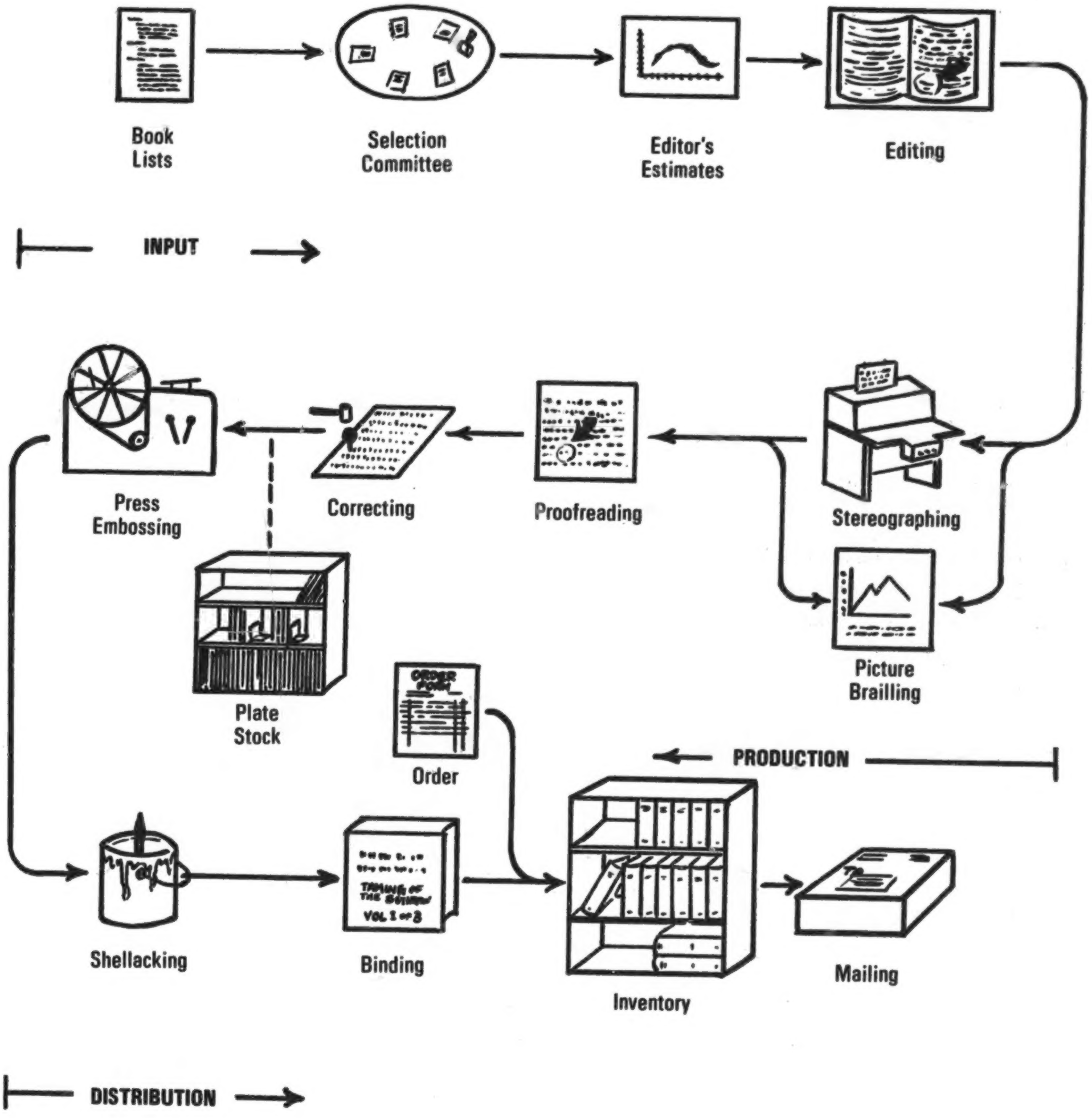
Copies for Sale?_______________ For Rent?_______________ For Loan?_______________

Page Size_______________ Name of Proofreader_______________ Year Transcribed_______________ "Completion" Report Date_______________

Proofreader Certified by Library of Congress? Yes_____ No_____ When_______________

Name and Address of Depository for Title_______________

Exhibit 4.8. Completion Report


Book Lists
Selection Committee
Editor's Estimates
Editing
INPUT
Press Embossing
Correcting
Proofreading
Stereographing
Picture Brailling
Plate Stock
ORDER FORM
Order
PRODUCTION
TAMING OF THE SHREW VOL 1 of 3
Shellacking
Binding
Inventory
Mailing
DISTRIBUTION

Approximate total cost:	$800.00 per title (40 copies—Library of Congress) $48.00 per magazine (600 copies—48 pages) $34.00 per magazine (2,500 copies—48 pages)
Approximate Elapsed Time:	About one year for books.

Exhibit 4.9. The Process of Producing Press Braille Books (Sources: See text.)

Title	Price		
	Hard Cover	Paper Back	Press Braille
Modern Geometry, Jurgenson	$5.20	–	$93.00
Psychology for Living, Sorenson and Malm	5.32	–	37.20
Applied Economics, Dodd	4.48	–	41.50
Bill Russell of the Boston Celtics Hirshberg	3.25	–	5.10
A Man Called Peter, Marshall	3.50	–	12.75
Wolf Cub Scout Book	–	.45	4.65
Bear Cub Scout Book	–	.45	3.15
Lion Webelos Cub Scout Book	–	.45	3.65
Catcher in the Rye, Salinger	3.00	.75	6.30
Spy Who Came in From the Cold, Le Carre	4.50	.75	6.30
Von Ryan's Express, Westheimer	4.95	.75	10.20
Winter of Our Discontent, Steinbeck	4.50	.75	13.95

Exhibit 4.10. Representative Book Prices (Sources: *Cumulative Book Index: General Catalog of Braille Publications*, 1966, American Printing House for the Blind.)

The cost of producing one plate-page of braille by this method is about $180.[20] Transcribing costs account for approximately two thirds of the nonprofit price of a braille book.[21] A qualified transcriber can produce about 50 correct pages of braille prose per day.[22]

5. *Proofreading:* Because of the high standard of accuracy required of press braille, proof copies are often proofread two or even three times before acceptance.[23] This is, of course, an expensive and time—consuming process.

6. *Correcting:* Errors in braille plates must be corrected by pounding out the dots with a hammer and correcting tool and then reembossing the correct cells.

7. *Press-Embossing:* The embossing of the braille pages is done by embossing presses. Production rates range from 1,600 to 2,400 pages per hour on hand-fed, flat-bed presses used for short book runs to 20,000 to 32,000 pages per hour on rotary presses used for long magazine runs.[24] Hand-fed flat-bed presses are most commonly used.

8. *Stock and Inventory:*—After a press run the zinc plates are placed in plate stock for use again if needed. Plates must be kept until the braille book is completely removed from print, after which time plates are melted down for reuse. Plate storage facilities for the large braille presses require considerable plant area.

The completed braille books are put into inventory for distribution. An average press-braille run of about forty copies of a title, the number which would normally be required for circulation by the Library of Congress, costs about $800.[25] Approximately, one year usually elapses between inkprint publication or choice by the committee and publication in braille.[26] Production costs for a 48-page magazine are approximately $48 each in 600 copies and $34 in 2,500 copies.[27]

Duplicated Braille

A relatively new method of producing copies of braille books from an existing copy is now in use by about sixty braillist groups. The method, called thermo-

Subject	*Price*
Agriculture	$ 7.69
Art	10.68
Biography	6.65
Business	9.74
Children's books	3.06
Economics	7.63
Education	5.50
History	7.73
Law	9.96
Poetry	4.11
Medicine	11.22
Music	6.98
Novels	4.86
Religion	4.63
Science	10.99
Sports	6.13
Technology	11.02
Average—all books	6.93

Exhibit 4.11. Average Retail Price of Hard-Cover Editions of Inkprint Books (Source: *Reader's Digest Almanac.* 1966 Edition.)

forming. uses a modified table-top vacuum-forming machine originally developed for "blister packaging" of three-dimensional objects in plastic film. The thermoforming method is extremely helpful in cases where copies of an already-existing braille book are requested or where the number of copies of a requested book are not sufficient to warrant the making of zinc press plates. Up to fifty copies can be made from a paper master.[28]

This Thermoform 55 vacuum-forming equipment distributed by the American Thermoform Company costs about $450. and the plastic sheets on which the braille is embossed. called Braillon. costs about $.04 per sheet in lots of 2.000. Approximately 150 copies per hour can be made by thermoforming.[29]

THE PRESENT COSTS OF BRAILLE MATERIAL

The cost of braille material vary widely depending upon the source or producer. Volunteers and braillist groups may charge only for paper and binding. although some provide braille material completely free of charge. Blind service organizations and agencies supported by philanthropic foundations supply much of their material free of charge. while the rest may be supplied either at cost or. through subsidy. for a fraction of cost.

The braille presses usually have fixed prices based on labor and production costs for the material they sell. Exhibit 4.10 lists some representative prices for press-braille books. Exhibit 4.11 lists average retail prices for hard-cover editions of inkprint books. Because of the limited selection of press-braille books and the large number of books for school-age children listed in the press-braille catalog. no corresponding averages have been computed for braille books.

REFERENCES

1. *Volunteer Braille Transcribing.* rev. ed. Washington. D.C.: Library of Congress. Division for the Blind. 1961. p. 3.
2. *Ibid.*. p. 2.
3. *Ibid.*. p. 3.
4. *Ibid.*
5. Tabulated from Annual Reports of the Librarian of Congress. section on the Division for the Blind. years 1959 through 1965.
6. Personal letter from Miss Ruth L. Keyes. Head. Volunteer Services Section. Division for the Blind. Library of Congress. Washington. D.C.. June 6. 1966.
7. *Ibid.*
8. *Volunteers Who Produce Books.* Washington. D.C.: Library of Congress. Division for the Blind. May. 1965. and supplement November. 1965.
9. Personal letter from Mrs. William T. Smith. Resource Secretary. National Braille Association. New York City. June 27. 1966.
10. Letter from Miss Ruth L. Keyes.
11. Personal interview with Mrs. Thetis Nyitray. National Braille Press. Boston. Massachusetts. March 12. 1965.
12. *Directory of Agencies Serving Blind Persons in the United States.* New York: American Foundation for the Blind. 1965. pp. 209-15.
13. *Ibid.* p. 6.
14. Haycraft. Howard. *Books for the Blind.* rev. ed. Washington. D.C.: Library of Congress. Division for the Blind. 1964. p. 8.
15. *Ibid.* p. 6.
16. Personal interview with Carl Lappin.
17. Haycraft. *Books for the Blind. op. cit.*. p. 6.
18. *Ibid.*. p. 7.
19. Personal interview with Robert Haynes. American Printing House for the Blind. Louisville. Kentucky. April 19. 1965.
20. *Ibid.*
21. Telephone interview with Mrs. Merrill Maynard. certified proofreader. Taunton. Massachusetts. August 22. 1965.
22. Telephone conversation with Harry Friedman. Manager. Howe Press of Perkins School for the Blind. Watertown. Massachusetts. January 11. 1967.
23. Personal interview with Robert Haynes.
24. *Proceedings of the International Congress on Technology and Blindness.* Vol. III. New York: American Foundation for the Blind. 1963. p. 140.
25. Haycraft. *Books for the Blind. op. cit.*. p. 4.
26. *American Printing House for the Blind. Inc.* Louisville. Ky.: APHB. 1964. p. 9.
27. *Proceedings of the International Congress on Technology and Blindness. op. cit.*. pp. 136–7.
28. Krebs. Bernard M. "A Braillist Talks with Resource Teachers." *The New Outlook for the Blind.* April. 1959.
29. *Proceedings of the International Congress on Technology and Blindness. op. cit.*. pp.125-6.

Chapter 5

Technological Advances in Braille Production

The increased demand for convenient, rapid sources of braille has spurred much research in braille production and distribution. Major efforts have been directed at applying computerized language translation and data processing, transmission, and storage technology to enhance braille production. This has resulted in a number of devices and systems which may be able, partially, to mechanize some of the functions of braille production.

THE BRAILLE SYSTEM

In order to provide a systematic approach to the way these new devices and techniques fit into the braille production and distribution system, the model of the system shown in Exhibit 5.1 can be used. This shows that the system can be segmented into three elements—input, production, and distribution—each of which performs a distinct activity. The system is activated by a fourth element, the braille readers, and it functions amidst an environment of social, political, and economic factors.

The input element transforms the reader request or market demand into a form suitable for transcription into braille. For example, in the present braille production system the input function may be performed by a braillist group chairman who receives the request, processes it, obtains the book to be brailled, and assigns it to a braillist. On the other hand, it may be a braille editor who determines the demand for a book and decides whether it should be produced in press braille.

The production element transforms inkprint into braille. In braillist groups this function is performed by the transcriber. In braille presses the combined effort of transcriber and press department performs the function.

The distribution element disseminates the brailled material from the producer to the braille reader. This function is presently carried out by braille libraries, braille presses and publishers, and braillist groups.

Each of these elements, therefore, is not really a mechanical device at all but, rather, a skilled person or, in the case of distribution, an individual or organization. Any devices used are incidental to the process. The human is the major functioning component.

BRAILLE RESEARCH

At present, four major systemic problems make braille production difficult. These are transcription complexities, production problems, distribution problems, and storage and display problems. As a result, braille research has been directed toward the following goals:

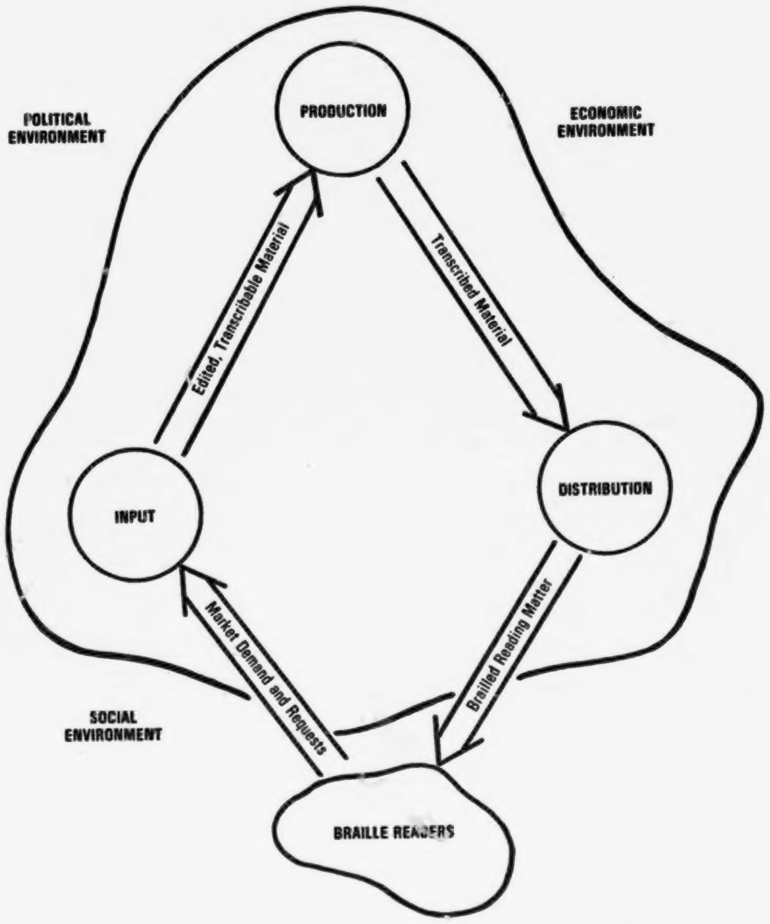


Exhibit 5.1. Model of the Braille Production and Distribution System

1. Making it possible for less-skilled personnel to produce accurate braille.
2. Developing methods for more rapid production of brailled material.
3. Making it possible for a blind reader to obtain braille material easily and rapidly.
4. Reducing the physical size of braille material, especially for library-storage purposes.

It is intended that the devices developed by this research will greatly enhance the performance capabilities of the operator. This mechanization will not obviate the need for skilled braillists. Rather it will enable more of them to work on technical, specialty, and nonstandard works which are now in great demand and which are not as suitable for machine translation.

In cases where machine translation is inferior to manual production, especially in regard to economics and performance, serious consideration must be given to the efficacy of mechanization. Technological sophistication and even efficiency are not always valid criteria for the adoption of new systems. Indications are that machine translation will be useful primarily in the press-braille production process. Single-copy requests and other areas in which manual retranscription is necessary or special formats are needed are not as suitable to machine translation.

Production purposes, however, are not the only purposes that rapid translation of braille serves. Just as the learning processes of sighted students are enhanced by the capability of instantly seeing what they have produced and what mistakes they have made, rapid braille translation can possibly provide a similar advantage for blind students.

For example, much of the work normally written longhand by sighted students must be typewritten by blind students. However, blind students are not self-sufficient. They must rely on a sighted reader to point out errors or to read back their work.

Using a device upon which the blind student can type his paper yet have a simultaneous braille copy to check for content or maintain for reference may be very useful. Similarly, a simple one-to-one translation to braille could provide for checking typing errors.

While purely production-oriented economic considerations might not warrant such uses, the effect of this interaction on the learning processes of a blind student may be invaluable. Similarly, the opportunity offered to others such as blind computer programmers who can obtain output directly in braille or blind employees who can have access to material without having to depend upon a sighted aide may transcend purely economic considerations.

AUTOMATED BRAILLE PRODUCTION CONCEPTS

Grade 2 Braille-Translation System Concepts

The major system approach to automated braille production has been based on computerized Grade 2 braille translation programs developed during the last few years. Exhibit 5.2 shows a block diagram of this type of system.

Material Sources

Two sources of material can be used. Inkprint material—books, magazines, documents, and so forth—may be supplied for copying as is normally done at present. Another source—compositor's media—is now very compatible with this new type of system also. Trends toward automation in the printing and publishing industry have resulted in the development of new typesetting procedures. Instead of setting type directly, the printers first make tapes or films of the work to be run. These can be edited, corrected, or amended either by hand or, in advanced systems, by special computers more quickly and economically than type galleys. The media are then used as inputs to typesetting equipment. Once type is set, the media are no longer needed by the printer.

These compositor's media are a great boon to braille transcription, however. Instead of being discarded, they

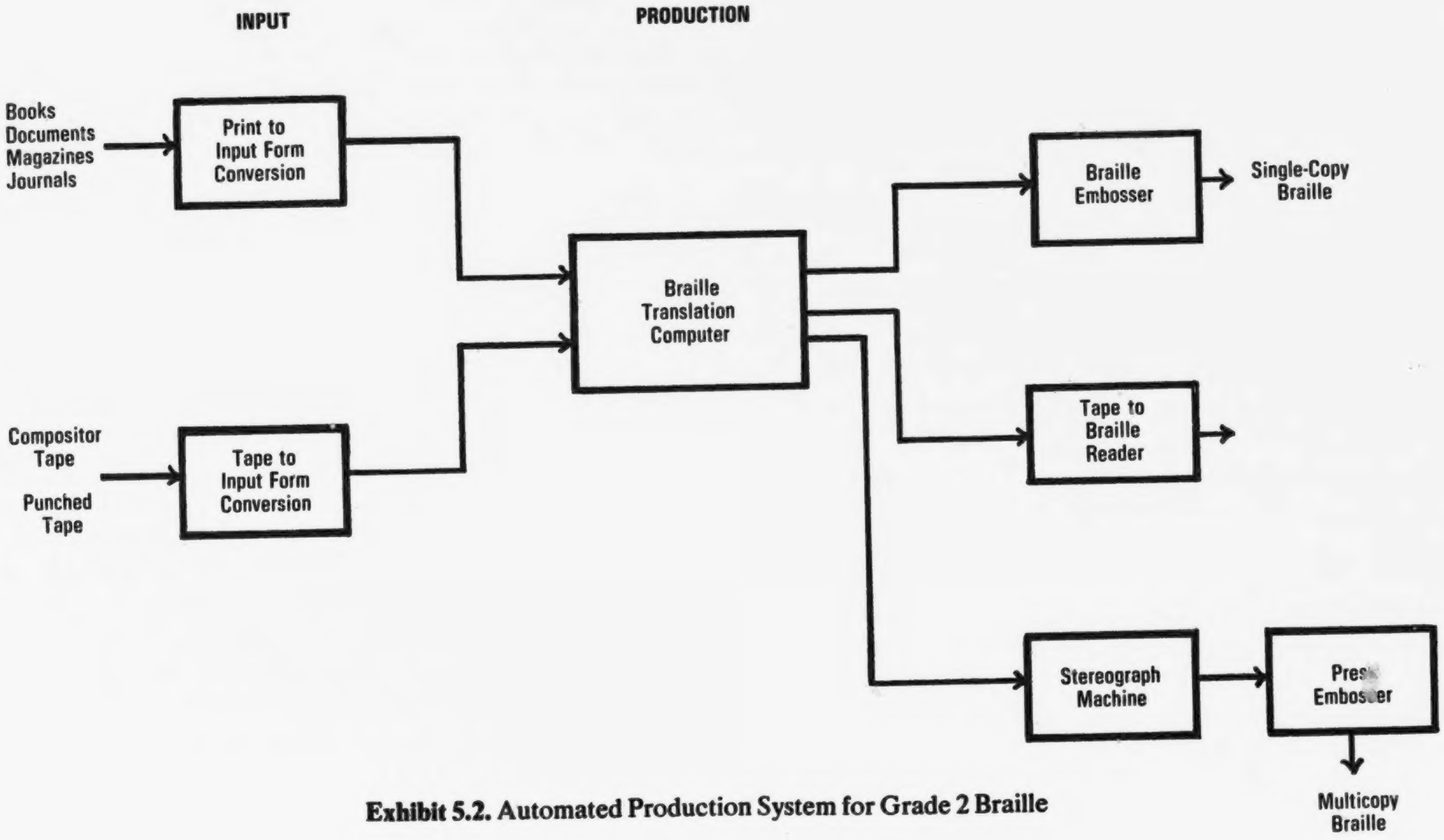

INPUT
PRODUCTION
Books
Documents
Magazines
Journals
Print to Input Form Conversion
Compositor Tape
Punched Tape
Tape to Input Form Conversion
Braille Translation Computer
Braille Embosser
Single-Copy Braille
Tape to Braille Reader
Stereograph Machine
Press Embosser
Multicopy Braille

Exhibit 5.2. Automated Production System for Grade 2 Braille

can be used, with varying amounts of editing required, as inputs to a braille translation system, totally avoiding the necessity of having to read or recopy the inkprint material. Thus, the most time-consuming and most expensive step is eliminated.

Input

The function of the input device in this system is to convert the material sources into forms that can be fed directly to the translation computer. Various input devices may be used. Direct input may be accomplished via an input console such as a teletypewriter unit connected to the computer. On the other hand, tape-makers or card punches may be used to produce intermediate cards or tapes that can first be corrected or amended and then fed to the computer. In either case, an operator must read and type the material being submitted; however, she need not know braille at all. She types as she normally would except for inserting special formatting symbols such as for foreign words, italics, or page endings.

Although character readers—machines that read printed inkprint characters for input into computers—are still very expensive and are being used only in specially engineered applications, new developments in this area may make it possible to use machines such as these for reading inkprint material to be brailled, thus eliminating the retyping step.

For compositor's media, special hardware and software (computer programs) have been developed for reading the printer code from the tapes and converting it into translator input code. This system, too, eliminates the reader-typist step.

Production

The production device in this system is the braille translation computer. A variety of programs for translating to braille have already been developed for use on large general-purpose computers. Continued research is being carried on in methods to increase translation speed and to allow for specialized formats and for material such as mathematics and foreign languages. In addition, new programs are being developed for use on smaller computers. In the same area the feasibility of building smaller, inexpensive computers designed specifically for braille translation is being investigated.

Output from the computer can be in the form of signals for direct transmission or, more probably, tapes or cards which can be used to operate distribution devices.

Distribution

The distribution devices convert the output from the translation into brailled reading material. A number of devices have been developed to do this. For single-copy brailled material specially developed braille embossers of various types and speeds are available. Standard computer print-out machines can also be used to emboss readable braille without impairing the normal operation of the unit by placing a soft surface on the backing platen. Very high-speed embossing of good-quality braille is now performed on specially modified print-out machines.

For multiple-copy braille the computer output, usually in the form of punched cards, is fed into modified braille stereograph machines which produce the zinc plates for press braille. These plates can then be run on the standard braille embossing presses.

A totally new concept in braille output now under development is the tape-to-braille reader. With this system standard punched paper tape is the braille medium. The holes in the tape are punched in the normal configuration and manner; however, they correspond in a special way to the dots in a braille cell. The punched tape is fed into a small, shoebox-sized tape-to-braille reader which displays a braille line. Usually, the display is a moving line, with the cells moving slowly past a stationary point in a manner similar to the moving-light news display at Times Square in New York.

There are two major advantages to the tape-to-braille system. First, the punched paper tape can be produced rapidly on tape punches which are less expensive than rapid braille embossers. Second, punched paper tape offers a bulk and weight reduction over standard embossed-braille material. A roll of punched paper tape occupies only one third the space of the regular braille material it would produce.[1] This would make for much easier distribution. However, to be able to use these tapes, the braille reader would have to have the tape-to-braille reader available.

It is also envisioned that tape-making capability can be incorporated into the reader. Thus the unit can be used for note-taking, personal correspondence, and other writing situations as well as for reading. Small, inexpensive reader units are presently under development, and research in the reading dynamics of moving-line braille is being conducted.

Other Concepts

Three partially automated system concepts for producing braille for special purposes are shown in Exhibit 5.3.

Semiautomated Braille Translation

A much simpler and much less expensive system for producing braille is shown at the top of Exhibit 5.3. This system is somewhat of a compromise between the totally automated braille translation system and the manual braille translation. Here, too, an operator reads the printed material and types it on a keyboard. However, the keyboard contains many of the braille symbols, contractions, and short-forms in addition to the standard letters and numerals.

The typist, then, just uses the appropriate keys in her typing. Because of the special rules on position and use of braille forms, the operator must know these rules in order to produce Grade 2 braille. However, she would

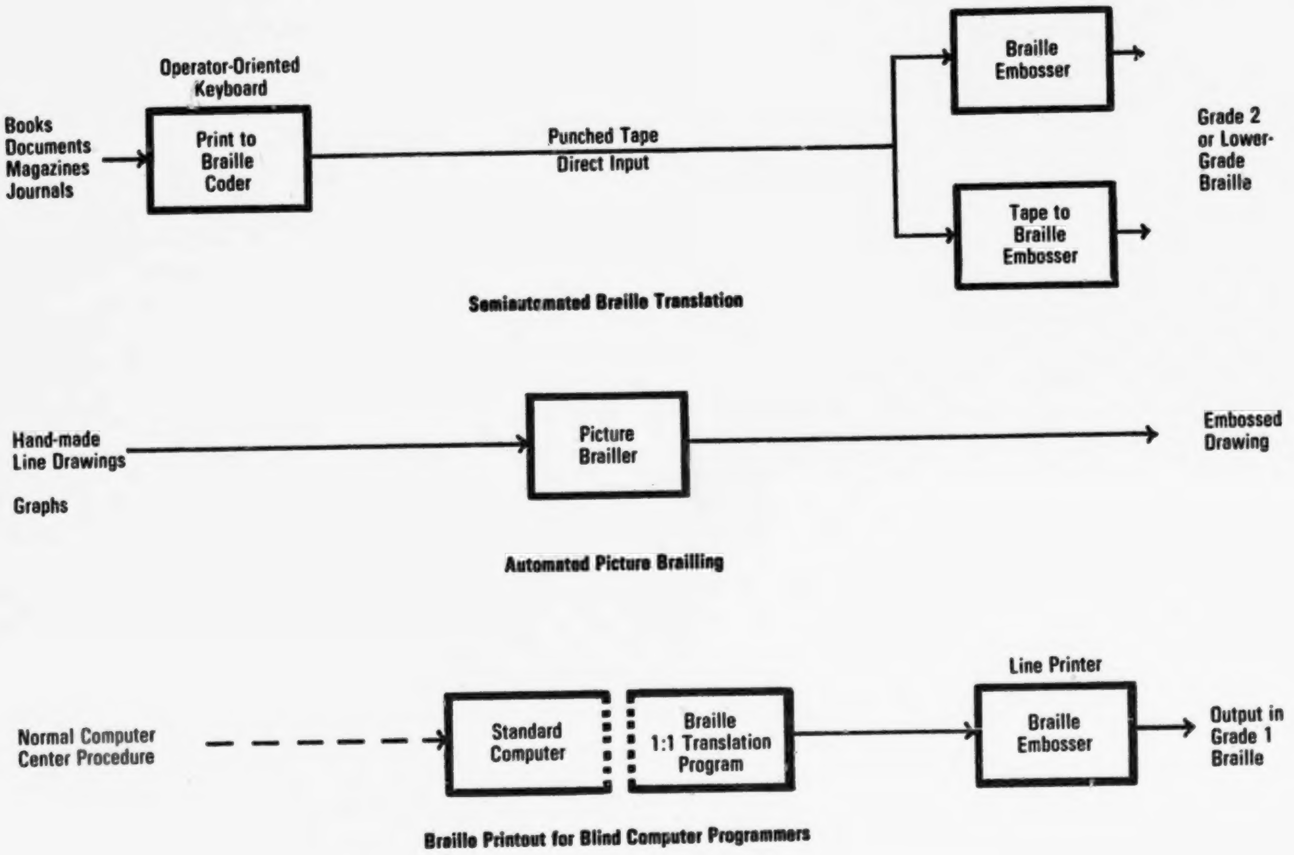

Operator-Oriented Keyboard
Books
Documents
Magazines
Journals
Print to Braille Coder
Punched Tape
Direct Input
Braille Embosser
Tape to Braille Embosser
Grade 2 or Lower-Grade Braille
Semiautomated Braille Translation
Hand-made Line Drawings
Graphs
Picture Brailler
Embossed Drawing
Automated Picture Brailling
Normal Computer Center Procedure
Standard Computer
Braille 1:1 Translation Program
Line Printer
Braille Embosser
Output in Grade 1 Braille
Braille Printout for Blind Computer Programmers

Exhibit 5.3. Partially Automated Braille Production Systems

not need to know the braille-cell equivalents for what she is typing. Use of this system by someone less familiar with the braille rules would result in a lower grade of braille. Typing in the standard manner would still give Grade 1 braille.

In this system, then, the input device is essentially only a braille coder, linking each key on the keyboard to a corresponding braille cell. The direct or tape output from this unit can be used to drive embossing or tape-to-braille equipment.

Automated Picture Brailling

The present procedure for conveying pictures in braille is for the braillist to lay out the image in pencil and then emboss it into lines and dots with an assortment of tools. This embossing requires much time and patience.

The picture brailler concept, shown in the middle of Exhibit 5.3, alleviates some of this difficulty by producing an embossed drawing directly from the line drawing. Researchers are attempting to increase the versatility of the picture braille, perhaps for use directly on printed matter or pictures.

Computer Printout in Braille

A growing opportunity for employment of the blind is being offered in the field of computer programming and data processing. A number of programs for training the blind in this work are in progress and have been quite successful. In order to facilitate the reading of program output by the blind without the help of a sighted companion, a braille translation subroutine compatible with a variety of computers has been developed.[2] As shown at the bottom of Exhibit 5.3, this program is simply included as part of the list-and-dump routines of the computer. The program provides for a Grade 1 translation of the computer output.

This output can be embossed in readable braille on regular printout paper on the standard line printer, as mentioned earlier, without impairing the normal functioning of the printer. A line-set-up program must be used since one braille cell uses three printlines.

This scheme could probably also be used for translation of inkprint material into Grade 1 braille for those circumstances in which immediate translation of material is desired with no concern as to format or grade.

EQUIPMENT AND TECHNIQUES FOR AUTOMATED BRAILLE PRODUCTION

Automated braille production is, by and large, still in the development stage. Considerable work must yet be done before these new systems are functionally and economically capable of reliable, large-scale production. Nevertheless, much of the equipment and techniques needed for automated braille production are already available. Many of the devices used are standard pieces of computing, data processing, or data transmission equipment which have been proven over years of commercial use. These are readily available and can be used usually as is or, at most, with minor modifications. Other equipment for which extensive research and development has been needed is now available at least in prototype form. Similarly, the braille translation programs for computers have evolved to where they are now being used for limited production purposes.

There are actually a number of devices and techniques available for performing the various tasks involved in automated braille production. However, some are more suited to certain production capacities, use environments, system designs, and budgetary constraints than are others. As a result, a summary list of these devices is needed for answering the following questions:

1. What types of devices and techniques are available for enhancing the production of braille?
2. What do these devices actually do? How reliable and efficient are they? What is their present status?
3. What do these devices cost to purchase, to operate, to maintain?
4. What type of personnel are needed to operate the devices? What accommodations are needed to house and to operate the devices?

Answers to all these are needed for the design of an efficient, reliable, and economical braille production system.

The lists presented in this chapter cover the general types of equipment and techniques presently available. All these are at least in prototype form; those in the conceptual or purely experimental stage are not included. Because few of the specialty items listed have ever been produced in quantity or used in full-scale braille production, the information given, especially that on costs, is based on the best available estimates.

Devices are listed, along with their functions, costs, and characteristics. Where a number of very similar devices are commercially available—for example, tape punching machines—only a representative sampling is listed. Also, only average prices are listed, because many options are available with the equipment. Equipment details can be obtained in the references or from the manufacturer. Applications of the equipment in integrated production systems and the economic considerations of production will be covered in the next chapter.

The APH Computerized Translation System

Although a number of computer-translated-braille runs have been made in various places over the past few years, these have been done either in the context of translation-program research and development or as demonstrations of the system. Indeed, there have been some very impressive demonstrations made on a computer system at the Massachusetts Institute of Technology under the auspices of the Engineering Projects Laboratory and the Sensory Aids Evaluation and Development Center there whereby English text typed in on a remote typewriter console was immediately reproduced as Grade 2 braille on a nearby brailler-embosser connected to the system.

Nevertheless, the only operational automated braille-production facility—presently running on a semiproduction basis—is located at the American Printing House for the Blind in Lousiville Kentucky. This system, which employs an IBM 709 computer donated by the International Business Machines Corporation, is being used as a pilot project and research tool in computer translated braille. Because of its very low utilization level and its donated, pilot status, economics of automated braille production are only partially determinable. Nevertheless, the system has proven the feasibility of the idea and has contributed enormously to the development of computerized braille translation. A diagram of the Printing House system is shown in Exhibit 5.4. Exhibit 5.5 lists the equipment used, costs, and output rates.

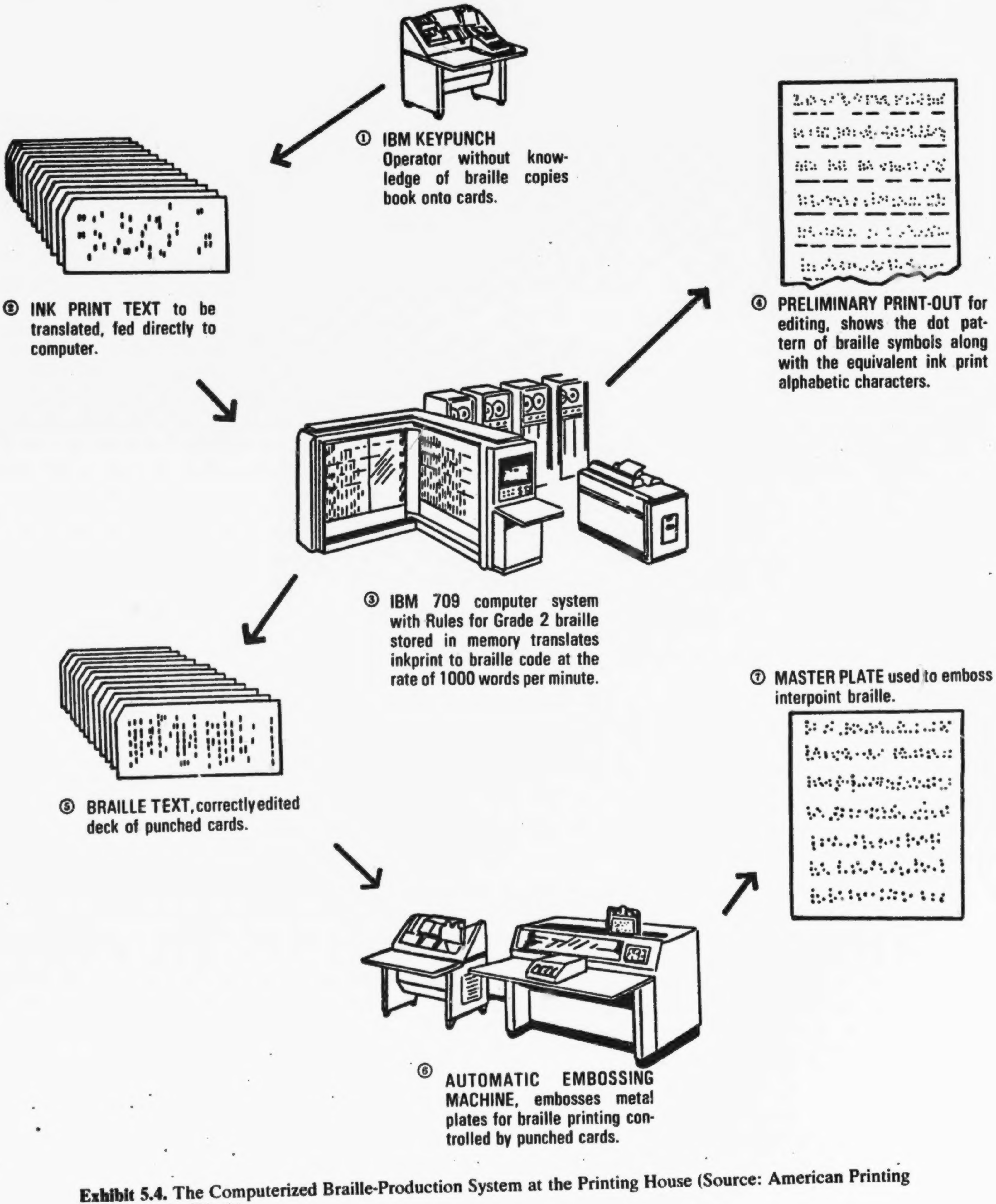
The Process[3]

1. *Editing:* The manual procedure for publishing braille requires that the printed text be edited before it is given to the transcriber. The same kind of preediting is required for the automatic system. The editor must decide how outlines and diagrams are to be presented, how special type faces are to be represented, what text changes are necessary where references are made to pictures, which portions of the text are in foreign languages, and many other such questions. These decisions are not based on a formal set of rules; they require an understanding of content and the ability to judge what will be easy for the blind reader to comprehend. For this reason, they cannot be made by the computer. It is expected that editing for the automatic system will be no more difficult and require no more time than editing for the manual system.

2. *Keypunching and Verifying:* The operators who prepare the input cards need know nothing about the braille system; they simply copy the edited text letter for letter. Some special codes are used to represent those print symbols for which there is no equivalent on the punch keyboard and to indicate various operational instructions. For example, a semicolon ; is punched $, and the = sign indicates that the succeeding character is capitalized.

It requires only about one or two days' training for a good keypuncher to master the special punching procedures. After this, her output averages approximately 50 braille-page equivalents per day[4] (compared with 50 fully translated plates per day produced by a skilled braillist-stereographer). The cards are then repunched on a verifier for error detection and correction. Rates for a skilled keypuncher and verifier in the Boston area average about $2.00 per hour.[5] A braillist-stereographer in the Boston area averages over $3.00 per hour.[6]

3. *Translation Program:* This program performs two important functions: the translation of inkprint to



① **IBM KEYPUNCH** Operator without knowledge of braille copies book onto cards.

② **INK PRINT TEXT** to be translated, fed directly to computer.

③ IBM 709 computer system with Rules for Grade 2 braille stored in memory translates inkprint to braille code at the rate of 1000 words per minute.

④ **PRELIMINARY PRINT-OUT** for editing, shows the dot pattern of braille symbols along with the equivalent ink print alphabetic characters.

⑤ **BRAILLE TEXT**, correctly edited deck of punched cards.

⑥ **AUTOMATIC EMBOSSING MACHINE**, embosses metal plates for braille printing controlled by punched cards.

⑦ **MASTER PLATE** used to emboss interpoint braille.

Exhibit 5.4. The Computerized Braille-Production System at the Printing House (Source: American Printing House for the Blind.)

Device	*Cost*	*Output*
(4) IBM 026 Card Punch	$60 per month	50 braille page equivalents per day
(4) IBM 056 Card Verifier	$50 per month	
IBM 709 Computer System	$50,000 per month rental fee plus $5,000 per month Maintenance (donated by IBM)	Translates about 1,000 words (about 2½ inkprint pages) per minute In production about 4 hours per day
Utilities	$1,000 per month	Total production time: about 2 hours per 100 braille pages
Site Adaptation	$50,000	
(3) Card-Operated Stereotype	$10,000 each	80 braille plate pages per day

Production Costs

Present: $1.80 per plate page (same as manual system) (includes overhead)
If no key-punching required: $.50 per plate page
Keypuncher Salary: $2.00 per hour (approximately, Boston area)

Exhibit 5.5. Equipment Used at the APH Computerized Braille Production Facility (Sources: Equipment and Costs: American Printing House for the Blind; Stereotype Costs: Howe Press; Punch and Verifier: (Bourne, *Methods of Information Handling*, New York: Wiley, 1963.)

braille and the insertion of special codes which control the make-up of the braille page. While this latter function is the less dramatic, it is extremely important; without it, this would be an interesting demonstration program rather than an operational system. The program insures that there will be the correct number of characters in a line and the correct number of lines on a page. It provides for centering chapter titles and inserting page numbers and also handles the special formats required by poetry and outline material.

The translation, one inkprint word at a time, is accomplished by reference to a dictionary stored in memory. This dictionary lists alphabetic and numeric characters, punctuation marks and special symbols, contractible letter combinations and exception words, along with their braille equivalents. Associated with each item in this list is a set of rules codes which provide information about the limitations on the use of these braille symbols. Each portion of the inkprint word for which there is a matching dictionary item is called a bite. After each entry is located in the dictionary, the rules codes are tested to determine the legality of that bite. When one inkprint word has been translated, the braille codes are moved to an output area; and during this transfer, format codes (end of line, end of page, and so forth) are inserted wherever appropriate.

Translation takes place at approximately 1,000 words per minute, and output cards are punched at 450 braille-page equivalents per hour. The computer is now used for production purposes only about four hours per day, and, since its installation in 1964, approximately 427 volumes comprising roughly 75,000 braille pages have been translated for production purposes by the computer.

4. *Retranslation Program:* This program helps to detect obvious translation errors, check the validity of braille codes, and provide a list of braille and inkprint symbols in a form suitable for proofreading. Because of the accuracy of the translation, this program is used just for occasional spot checks. Translation error rates are very low, approximately five errors in 30,000 words.[7]

5. *Proofreading:* Although the retranslation program does detect certain errors, it cannot determine whether the use of a contraction obscures recognition or pronunciation. This must be discovered by a proofreader. While the dictionary in the present program has proven adequate to translate the books published to date, it is entirely possible that unusual words occur for which dictionary entries are not present. Under the present procedure a preliminary translation of a portion of the text is printed and proofread before the entire

book is translated on the computer. This practice is based on the assumption that each writer uses a characteristic vocabulary and that a sample translation will provide the chance to make any required dictionary additions before translating the entire text. Additions to the dictionary are made automatically using another program.

When a correct proof-listing has been obtained, the output tape produced by the translation program is converted to cards. These braille cards, shown in Exhibit 5.6, are used to produce the master plates.

6. *Stereographing:* The zinc stereograph plates for the press masters are produced by the card-driven stereograph machine. Output of these machines is about 80 braille-plate pages per day. One operator can supervise a number of these machines operating simultaneously.[8]. The plates produced by these machines are the same as those produced on manual stereograph machines, and standard production procedure is used for the embossing and subsequent operations.

Availability of Material Sources

Inkprint Material

The major source for brailled material is, of course, inkprint books. For these, availability is no problem. Furthermore, to facilitate matters, blanket permission has been granted by members of the American Textbook Publishers Institute for translating their textbooks into braille, by members of the Children's Book Council for transcribing their children's books into braille, by the Association of American University Presses for their material, and by some publishers for transcribing all their books into braille.[9] Although application is necessary for other books and for anthologies, permission is usually granted.

Compositor's Media

Compositor's media will probably become a major source for braille material input. Advances in computer typesetting have made it possible—and necessary—to

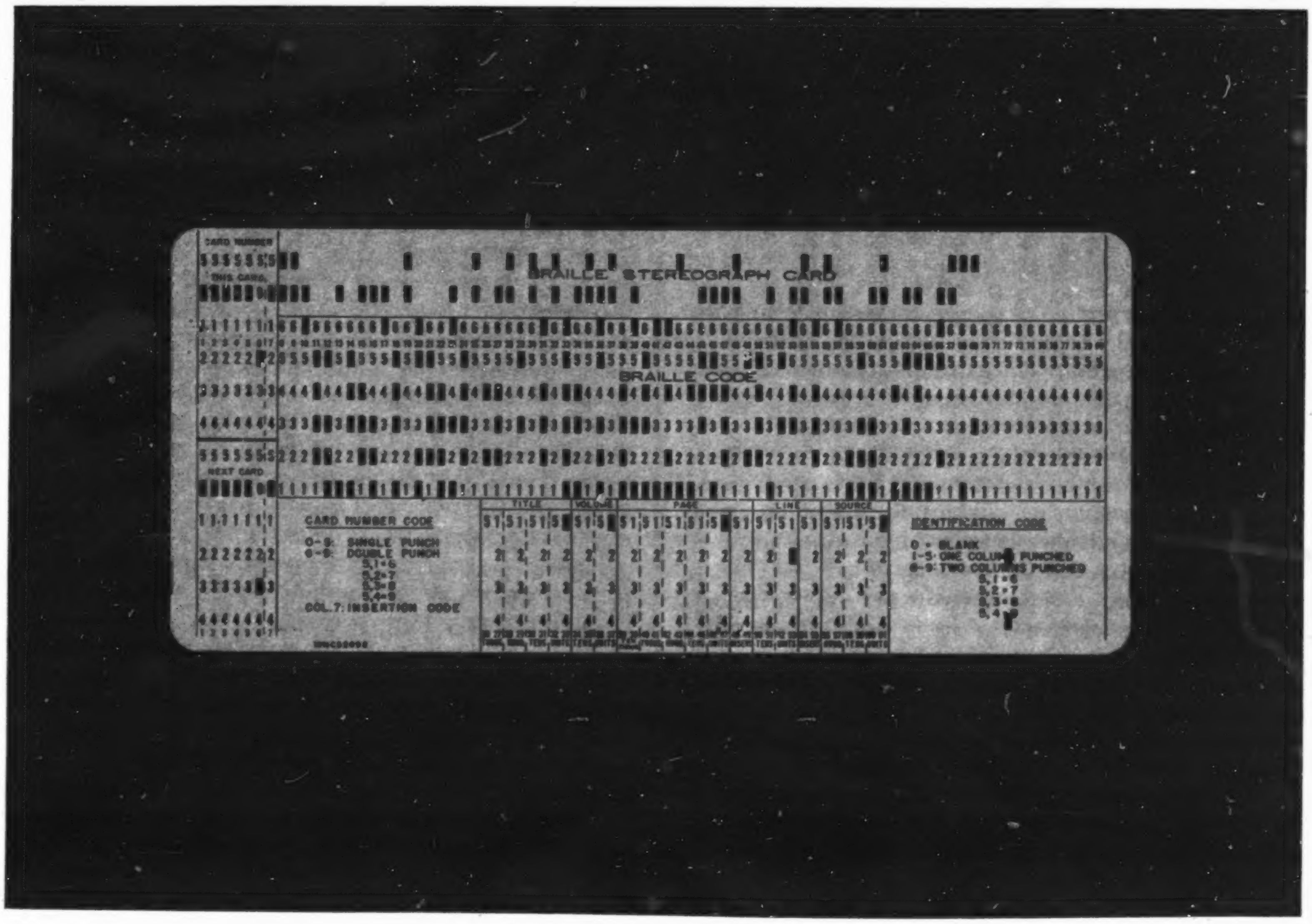

CARD NUMBER
THIS CARD
BRAILLE STEREOGRAPH CARD
BRAILLE CODE
NEXT CARD
CARD NUMBER CODE
0-5: SINGLE PUNCH
6-9: DOUBLE PUNCH
5,1=6
5,2=7
5,3=8
5,4=9
COL.7: INSERTION CODE
TITLE
VOLUME
PAGE
LINE
SOURCE
IDENTIFICATION CODE
0 = BLANK
1-5: ONE COLUMN PUNCHED
6-9: TWO COLUMNS PUNCHED
5, 1 = 6
5, 2 = 7
5, 3 = 8
5, 4 = 9

Exhibit 5.6. A Braille Stereograph Card (Source: A.S. Schack and R.T. Mertz, *Braille Translation System For The IBM 704*, New York: IBM, 1961.)

have virtually error-free media for type composition. Five major media systems—Teletypesetter and Linotype tape systems, Monotype, Linofilm, and Photon—are now compatible with computerized systems. Also, it is very encouraging that leading compositors are adopting these systems and the number of users is increasing.[10] To date, 290 computers are being used in the compositor industry for typesetting activities, and many compositors have agreed to make their media available for braille-input purposes.[11] Media made available for transcription will greatly increase the choice of material for brailling.[12]

Input Devices for Computers

In cases where source material is already in machine-readable form—compositor's media, punched tape, punched cards, and so forth—reading devices are available. Where source material is in print form and must first be translated, devices for transcription onto tape or cards for subsequent reading must be used. It is also possible to manually type the material directly into the translation computer via teletypewriter consoles.

Card-Punching Units

Present input to most computers for purposes of braille translation is via punched cards. As mentioned before, the procedure is essentially that of recopying inkprint text onto the cards, including format indicators as necessary. While the stacks of individual cards are somewhat unwieldy, errors are easily edited by removing the incorrect cards and inserting correct ones.

Although keypuncher output is about 50 braille-page equivalents per day, the cards must usually be verified —checked by a process not unlike repunching. Thus, the cards must actually be punched twice before they are ready for processing. This is a very slow method of input transcription for lengthy material. Equipment for punched-card input and its characteristics and costs are shown in Exhibit 5.7.

Tape-Punching Units

These units are essentially electric typewriters which, in addition to a typewritten copy of the material, also produce a code-perforated paper tape. Typing speed is approximately that of a regular typist, averaging about 50 words per minute. To edit, the typewritten copy is proofread and errors are noted. Because of the continuous property of the strip of punched tape, error correction is accomplished by punching a delete code over the error on the primary tape and then using it to produce a second tape, inserting corrections at the appropriate spots. This, too, is a very slow method of input transcription for lengthy material.

Tape-making equipment is shown in Exhibit 5.8, along with costs and characteristics.

Media Readers

Although punched-card input equipment is standard with large computers, media readers are not. Because, ideally, the input to high-speed computers is best done via magnetic tape, two steps are needed with compositor's media and punched tapes.

First, devices that can handle the media being read are necessary. Then, additional interface units are needed for converting the tape codes into computer codes and for placing the signals onto magnetic tape.

The devices required for both steps are listed in Exhibit 5.9.

Optical Reader [13]

One of the newest methods of reading material into a computer is by direct optical reading. Although most optical readers on the market today are designed to read specially designed characters, one unit, the Philco-Ford Multi-Font Reader, reads typewritten material and certain other type faces. Conceivably, the unit could be designed to read book type.

Such a machine may be valuable for directly reading inkprint books for which compositor's tapes are unavailable or have been discarded. At present, it would be very difficult to accommodate special symbols such as those used in mathematics and technology; standard format, common type fonts are the most amenable to optical reading. Output from the reader is on magnetic tape compatible with computer systems.

The Multi-Font Reader accepts approximately 180 pages per minute. Selling price is about $500,000 with maintenance at around $2,500 per month. Three-year leases are also available at about $15,000 per month.

The great capacity of the Philco machine has caused some users to sell time on the machine, much like a service bureau, in order to utilize the machine fully. Reading-time costs vary from 100 to 125 dollars per hour.

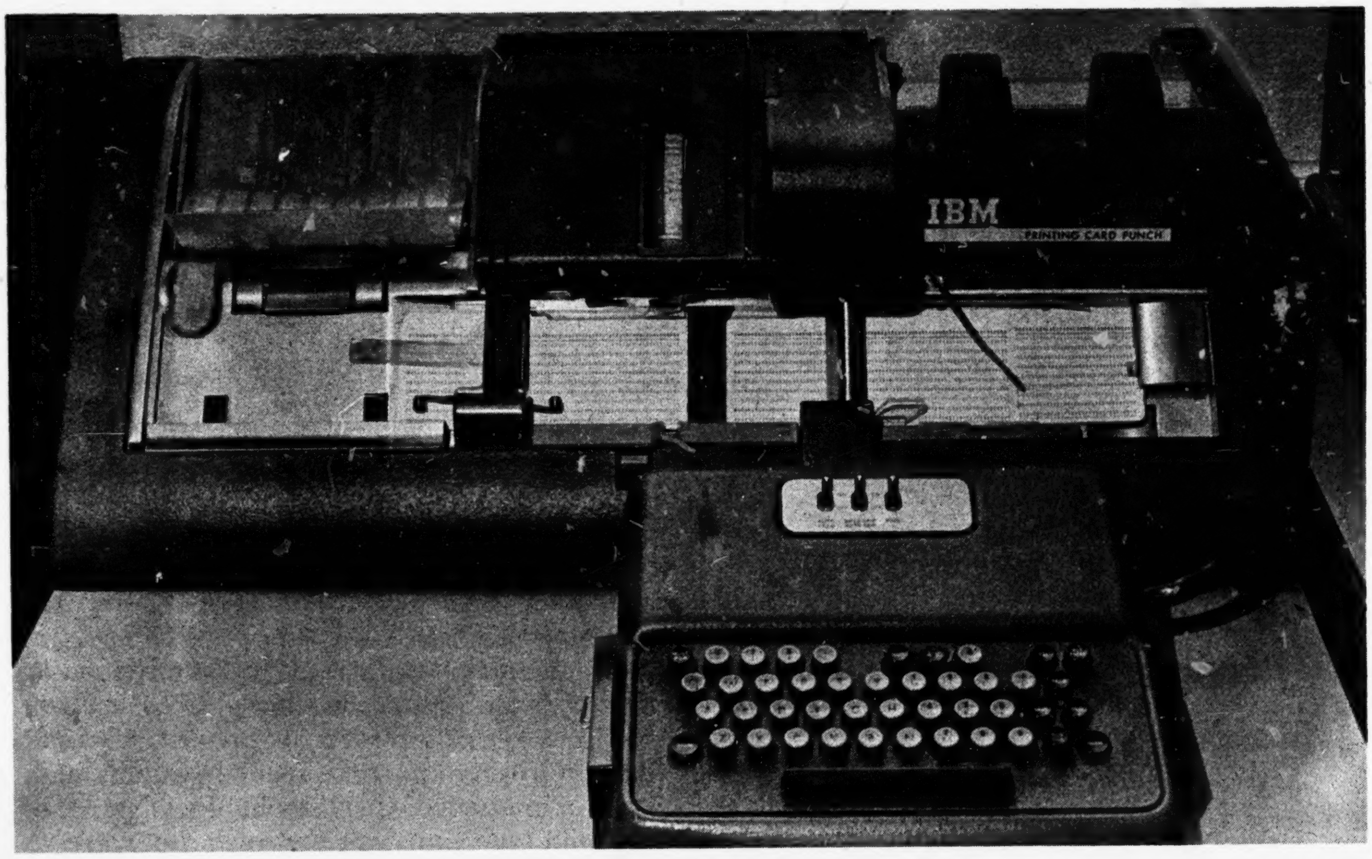
Exhibit 5.9 lists the characteristics of the Multi-Font Reader.

Because of the newness of optical character-recognition technology, research and development is taking place at a rapid pace both at Philco and at other companies. Improved accuracy, greater versatility in font reading, faster speed, and lower cost are expected as the technology progresses.

Direct-Input Devices

Another recent development in computer technology is the use of time-shared, multiple-access computers. With these systems, users have input consoles connected directly or by communication line with a central computer. Access to the computer is thus immediately available in a number of locations.

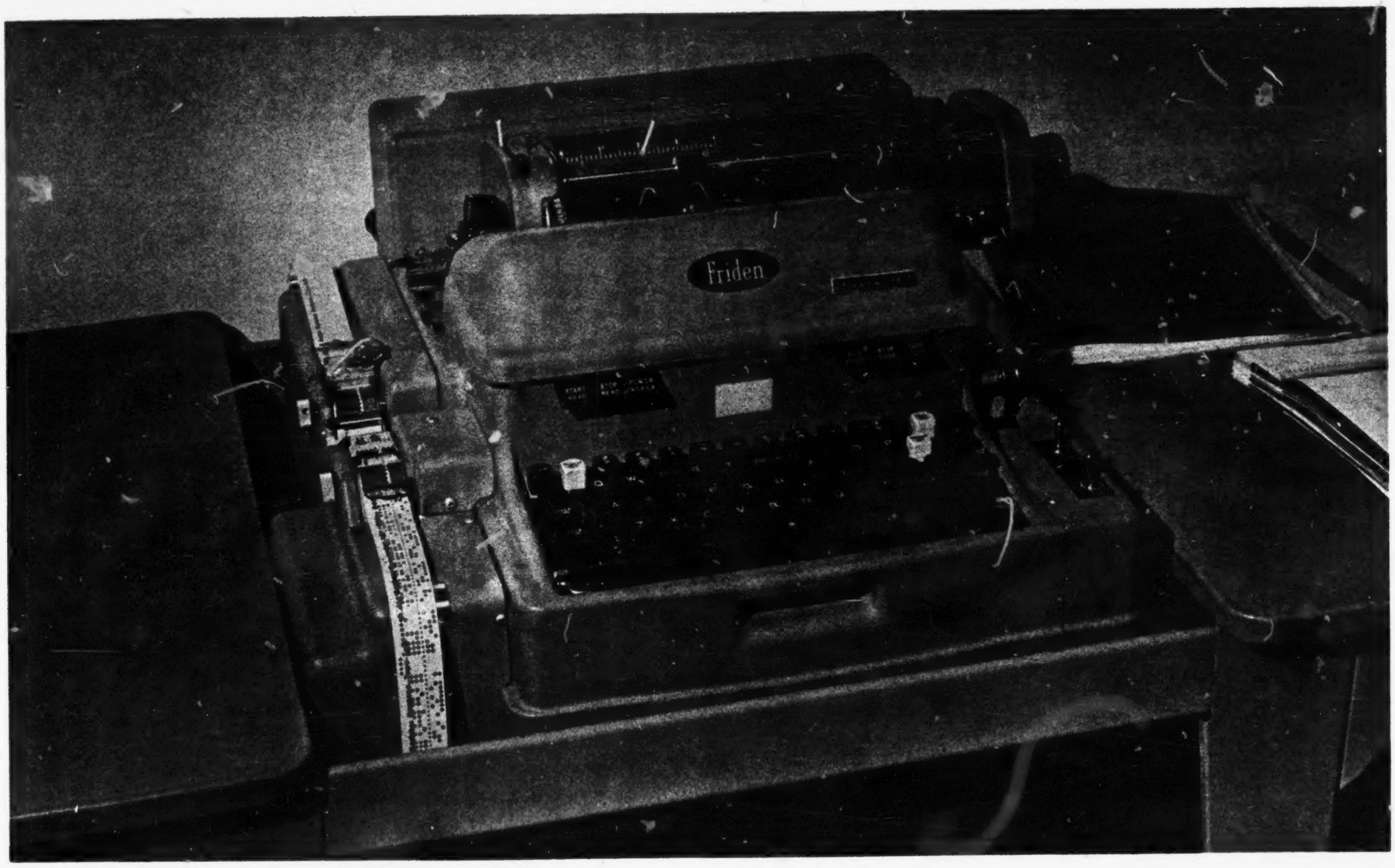
This type of access may be especially useful where rapid translation of braille is desired. A typist can type



IBM 026 Printing Card Punch

	IBM 026 Card Punch
Machine Costs	Rental—$60 per month Purchase—$3,825 plus $13 per month for maintenance Service bureau—$4 per hour
Personnel	Keypuncher salary about $2.00 per hour Operator need not know braille
Output	About 50 braille-page equivalents per day
	IBM 056 Card Verifier
Machine Costs	Rental—$50 per month Purchase—$2,725 plus $16 per month maintenance Service bureau—$4 per hour
Personnel	Same as above
Output	
	Accessories
Card Stock	$1 to $2 per 1,000

Exhibit 5.7. Punched-Card Input Devices (Sources: Equipment: C.P. Bourne, *Methods of Information Handling*, New York: Wiley, 1963; Output: American Printing House for the Blind.)



Friden Flexowriter Model FO

	Friden Model 2303 Flexowriter
Machine Costs	Rental—$90 per month Purchase—$2,795 basic, about $3,000 with accessories
Personnel	Operator salary about $2.00 per hour Operator need not know braille
Output	About 50 braille-page equivalents per day
	Other Devices (characteristics similar to above)
Remington-Rand Synchro-Tape Typewriter	Rental—$150 per month Purchase—$3,500
Invac TT-200 and Tape System	$3,500 with accessories
	Accessories
Paper Tape	Standard—$30 per thirty 1,000-foot rolls Heavy—$100 per thirty 1,000-foot rolls

Exhibit 5.8. Punched-Tape Preparation Devices (Sources: C.P. Bourne, *Methods of Information Handling*, New York: Wiley, 1963; Friden, Inc.)

the material into the computer and have the brailled version rapidly returned via the same system. Similarly, material such as short messages or letters, for which direct submission may be much simpler than retranscribing into another mode and then submitting it, may best be translated this way.

For direct input a communication terminal is required. This usually consists of a teletypewriter console and, if communication lines are used, a data transmission unit. Often a tape reader-punch may be included with the teletypwriter. Terminal equipment, costs, and characteristics are shown in Exhibit 5.10.

Communication Lines

For remote terminal installations communication lines must be used between terminals and computers. A variety of common, private, and leased lines are available in addition to standard telephone and teletype service lines. The choice made depends on location, amount of use, speed and quality of signal transmitted, and other similar factors. In some cases special data-transmission interface units are needed to make the terminal device signals compatible with the transmission lines being used.

Representative communications-facilities cost and equipment are given in Exhibit 5.11. Detailed costs for specific locations and applications should be obtained from the service companies.

PRODUCTION TECHNIQUES

While the computer is the actual device which performs the production function of translating the material fed to it from the input elements, it is really the braille translation program that is put into the computer that is of interest.

The Schack DOTSYS Program[14]

The DOTSYS program, developed by Schack Associates, New York City, and the MIT Sensory Aids Edu-

IBM Model CX Teletypesetter-Tape Reader

Cost	$425
Speed	110 characters per second (about 30 seconds per inkprint page)
Accessories	IBM 2972 communications interface Rental cost—$200 per month Other accessories may be needed.

MIT Monotype Tape Reader

Cost	Estimated at $1,500
Speed	250 characters per second (about 15 seconds per inkprint page)
Status	Developmental prototype

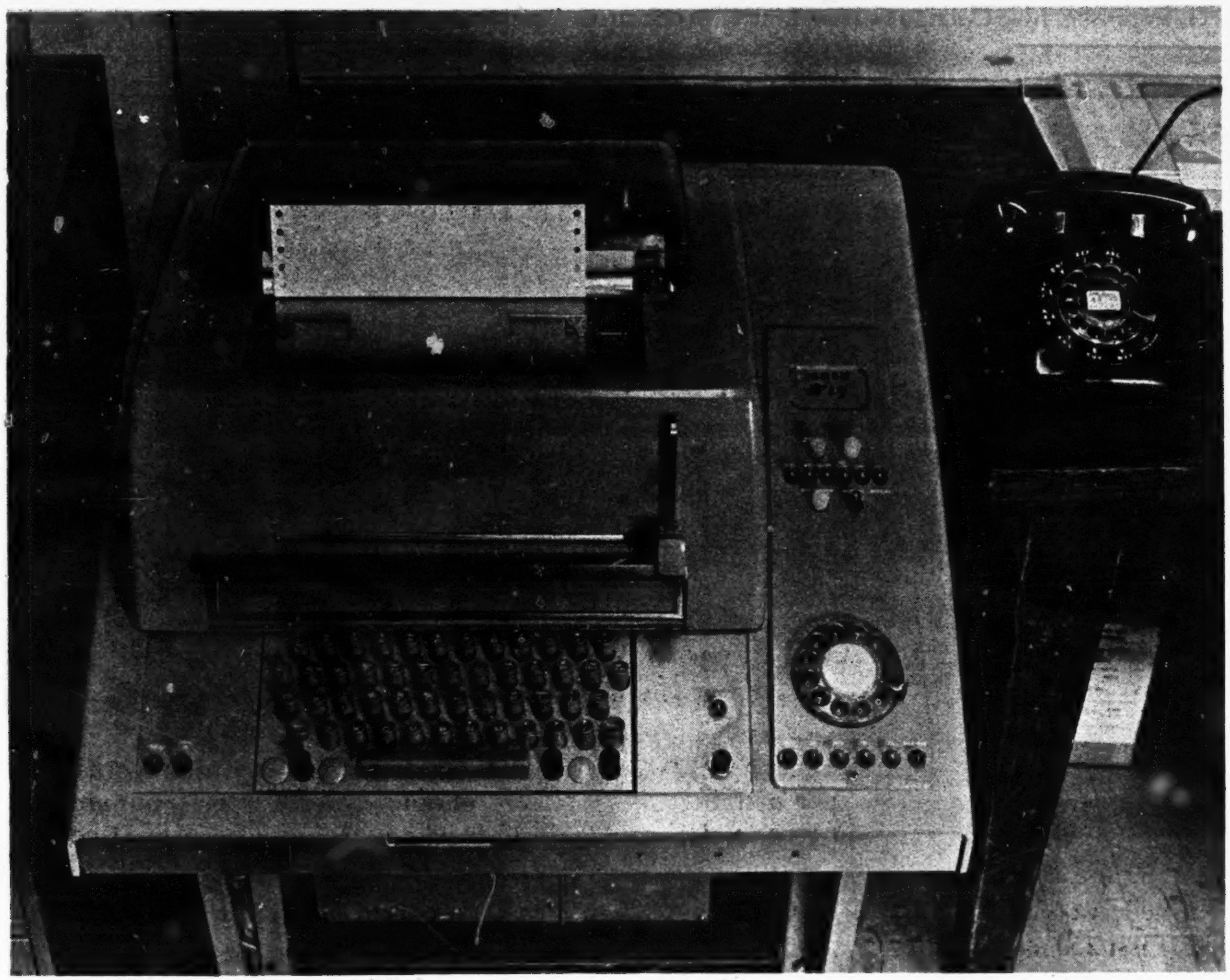
Paper Tape Readers

IBM 1011 (for IBM 1401 computer)	$500 per month
Speed	400 characters per second (about 6 seconds per inkprint page)
IBM 2671 (for IBM system 360 computers)	$144 per month
IBM 2822 tape recorder control for IBM 1011 and 2671	$216 per month

Philco Multi-Font Reader

Machine Cost	Rental—$15,000 per month Purchase—$500,000 plus $2,500 per month maintenance Service bureau—$100 to $125 per hour
Speed	180 inkprint pages per minute
Status	Presently does not read book-set type. Can probably be made to do so.

Exhibit 5.9. Media and Optical Readers (Sources: Model CX: IBM Corporation; MIT Reader: MIT Sensory Aids Center; Paper Tape: *Auerbach Standard EDP Reports;* Philco Reader: Philco-Ford Corporation.)



Model 33 Teletypewriter (leased from the Bell System)

	TWX Service[a]	*Data Phone Service*[a,b]
Keyboard operation	$45 per month	$70 per month
Keyboard, paper tape reader-punch	$60 per month	$85 per month
Nonrecurring installation charge	$25	

IBM Model 1050 Data Communication System

Line and Data Set (Phone Co.)	$35 per month[a]
1052 Printer-keyboard	$65 per month
Accessories	
1054 Paper-Tape Reader	$35 per month
1055 Paper-Tape Punch	$45 per month
1051 Control Unit	$100 per month

[a] Local service only.

[b] Includes data phone ($25 per month) and phone line ($10 per month) for voice as well as data transmission.

Exhibit 5.10. Direct-Input Terminals (Source: Commission on College Physics, *The Computer in Physics Instruction, Appendix B, p. 32.)*

Exhibit 5.11. Representative Communication Line Costs (Source: Commission on College Physics, *The Computer in Physics Instruction,* Appendix B, pp. 39-43.)

LOW DATA RATE CIRCUITS (less than 2,000 bits per second)

Teletype Exchange Services

If teletypewriters are used as terminals, one of the dialable teletype exchanges of the nationwide TWX (AT&T) or Telex (Western Union) system may be used at lower cost than ordinary telephone service.

Example One minute Telex between Ann Arbor, Michigan, and New York City: $0.30.

Local Telephone Service

Same as normal business telephone service.

Private Wire Leased Teleprinter Lines

Costs per Month (Half Duplex) [a]

	60 and 70 words per minute (5 level code)	100 words per minute (5 level code)	100 words per minute (ASCII code)
Line cost First 250 mi	$ 1.10/mi	$ 1.21/mi	$ 1.375/mi
Over 1000 mi	0.385/mi	0.424/mi	0.481/mi
Channel termination	12.50	13.75	15.625
Local circuit	6.70	7.37	8.375

Wide Area Telephone Service (WATS)

Wide area telephone service permits the user to dial any telephone or computer installation within a specified area for a flat monthly rental. Rates vary with calling area and areas callable.

Example Ann Arbor, Michigan, to

Entire state of Michigan	$700/month
Eastern lower peninsula	$400/month
Southeastern Michigan	$300/month
Zone 4 (extending from east coast to rocky mountains except Florida and Michigan)	$1,400/month
Zone 6 (continental United States except Michigan)	$2,050/month

(continued on next page)

Foreign Exchange Service

User's telephone connected in a remote exchange in another area.

Examples	AnnArbor, Michigan, to Detroit (40 miles)	$163/month
	Ann Arbor, Michigan, to New York City (515 miles)	$980/month

MEDIUM DATA RATE CIRCUITS (up to 3,000 bits per second)

Private Leased Line

	AT&T	
	Half Duplex	*Full Deluxe*
Mileage rate interstate	$ 2.02/month	$ 2.22/month
Mileage rate intrastate	4.25	4.68
Channel Termination charge	12.50	13.75
Local circuit charge	12.50	13.75
Conditioning charge		
1,200 bits/sec	None	None
2,400 bits/sec	37.50	37.50

DATA SETS FOR VOICE GRADE SERVICE

Data Set Series	*Data Rate* (bits/sec)	*Lease Price* (per month)
101, 105	110	$25
103	134.5	$25
202	0-1, 200	$40
201	2,000 or 2,4000 (synchronous)	$70

HIGH DATA RATE CIRCUITS *(greater than 3,000 to 4,000 bits per second)*

	Bandwidth (or data rate in bits/sec)	*Interstate Rate/Mile/ Month*	*TELPAK Data Set Rental* (2 required)
A	48 KHz	$15	$250 each/month
B	96 KHz	$20	
C	240 KH	$25	$550
D	1 MHz	$45	$1,300

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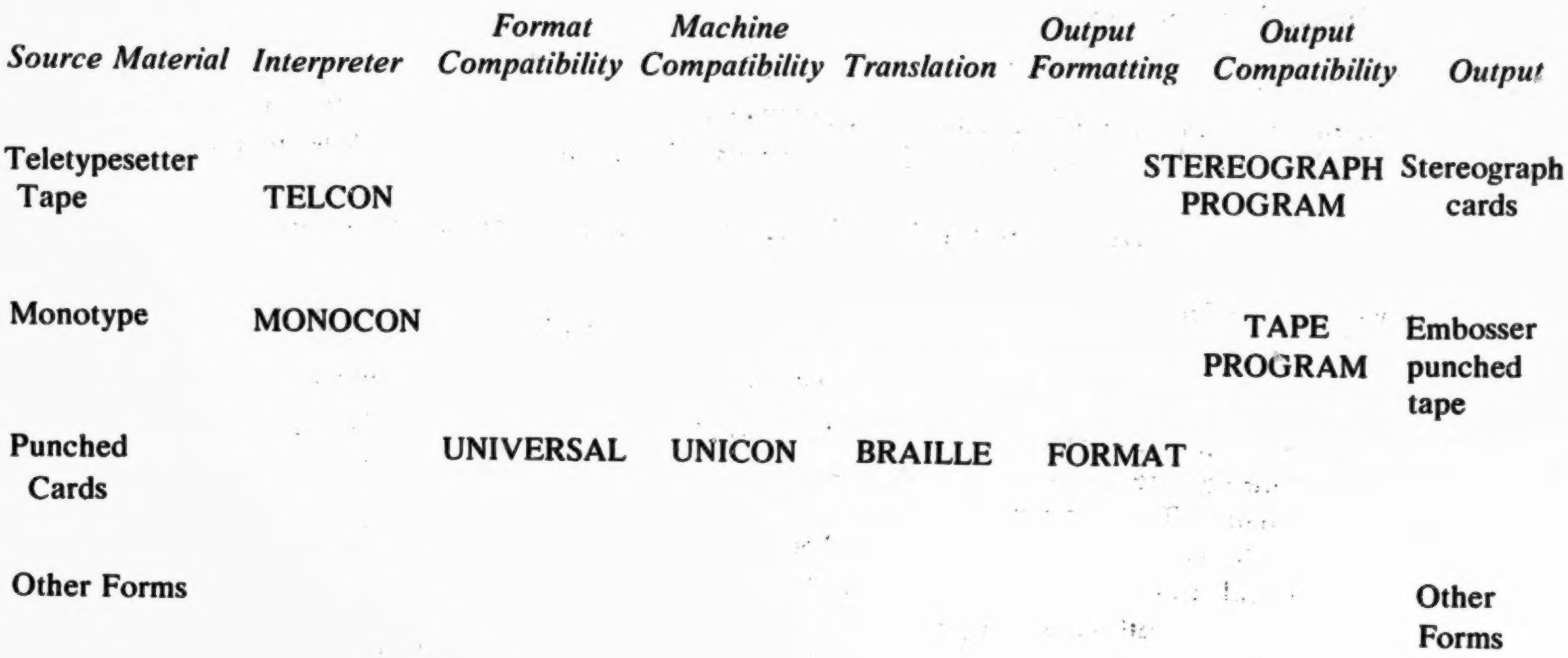
[a] Cannot send and receive simultaneously.



Production Rate: 200 braille pages in 4½ min. on an IBM 7094

Exhibit 5.12. The DOTSYS Braille Translation Program (Source: Schack Associates.)

cation and Development Center, is a totally integrated braille translation program for literary braille. It is capable of taking source material in any form—compositor's media, punched tape or cards, or direct input—and converting it into Grade 2 braille output—either on tapes, cards, or direct. This program is based on the Schack translation program presently in use at the American Printing House for the Blind.

Program Format

The program is actually a series of subprograms, each performing part of the production sequence. Exhibit 5.12 shows a diagram of the system along with some of the operation details, costs, and times.

1. *Interpreter Programs:* The interpreter programs—TELCON, MONOCON, and the like—provide the link between the individual compositor's media codes and the rest of the DOTSYS program. Thus, as new input source forms become available, only an additional interpreter subprogram need be written; no changes in the rest of the program are necessary. The interpreter programs interpret the source codes and convert them into an expanded code called UNIVERSAL.

2. *UNIVERSAL:*—This subprogram interprets the many symbols used as inkprint format indicators which are normally recognized from context by sighted readers. The program distinguishes the many different ways that paragraphing may be presented in inkprint and converts each of these to a special Start Paragraph code. It determines whether the symbol ['] represents a single right quote, part of a double right quote, or an apostrophe. It performs a scan to determine whether a [.] is a period or a decimal point. It provides information about centered headings, inserts the special codes for reference notes, indicates the beginning and end of italicized passages, and generally supplies much of the formatting information formerly inserted by a keypunch operator.

3. *UNICON:* The UNIVERSAL codes are converted by another program called UNICON, and the result is a stream of computer codes in the same form as a keypunch operator would have produced. This program determines the length of an italicized passage and supplies the appropriate codes whether the italicized portion be a part of a word, a single word, a stream of more than three words, or a series of paragraphs. It performs a similar scan to supply the proper capital signs, eliminates unnecessary spaces, and translates the UNIVERSAL format codes into the special codes required by the braille translation program.

4. *BRAILL:* The output from UNICON serves as input to the BRAILL program which does the actual translation into Grade 2 braille. This program is, essentially, the dictionary-lookup and rules-listing portion of the Printing House program described earlier.

5. *FORMAT:* The stream of braille codes from the BRAILL program is modified by a FORMAT program which inserts end-of-line and end-of-page codes, supplies spaces necessary to center material, determines whether a centered heading may appear near the end of the page, or whether a new page must be started.

6. *Output Compatibility Programs:* The formatted braille then becomes input to another program which produces appropriate codes to operate the embossing equipment. Two such programs have been written—one to produce a tape for the high-speed, tape-controlled embosser, and another to produce cards for the card-controlled stereograph equipment. Here, too, when other output is desired, only an additional compatibility subprogram need be written.

Equipment and Speed

The full DOTSYS program has been run primarily on the IBM 7094 with 8K (8,000 words) of storage. For direct reading of teletypesetter tape into the computer, the CX tape reader mentioned earlier is connected to the computer.

The 7094 processes the material through the complete program at the rate of 200 braille pages in 4 1/2 minutes.[15] The primary reason for having used the 7094 computer has been its availability. It is likely, however, that the program could be run on a smaller machine; no studies of this have been made as yet.[16] A smaller machine would require more processing time but at a lower cost, so that the economic aspect would be a major criterion. Also, because of the speed and characteristics of the program, it is best to run the program as a unit on one machine.

Implementation

The translation and output subprograms of the DOTSYS system have been in operation under production conditions at the Printing House with punched-card input and have proven themselves admirably. The compositor's media input program—a more recent development. and not as complex as the translation program—has been successfully run under simulated production conditions and is deemed ready for production use.

At present, teletypesetter tape is the only compositor's medium being read, and further interpreter subprograms will be written as needed. Also, the DOTSYS system presently handles only literary braille, but a Nemeth-Code mathematics translation routine is under development.

The Medcomp BRAILLETRAN Program[17]

The BRAILLETRAN program, developed by the Medcomp Research Corporation, Cincinnati, Ohio, is another sophisticated Grade 2 braille translation program. While the program accomplishes much of the same as does the DOTSYS program, there are both some conceptual differences and some operational differences. Input to the system is presently from punched cards only, while output can be either on magnetic tape, punched cards, or direct. In addition to the braille literary codes the program also handles the Nemeth Code for mathematics, common foreign languages in a special type of Grade 1 braille, and table listings.

Program Format

The BRAILLETRAN system uses two separate programs. All translation and formatting are performed by a single program. A second program, the BRAILLETRAN companion program, is used for embossing. Because translation and formatting are in a single program, output cannot be edited. Also, the program is not presently equipped to accept such input sources as compositor's media, but these additions are contemplated.

A keypuncher punches source material onto cards in English; she need not know braille. In addition, she must include control statements, key words enclosed in slashes which direct formatting translation mode, and output modes and formats. Translation errors are said to be less common than in hand-transcribed material. A detailed description of the program and its uses is available from the Medcomp Research Corporation.

Equipment and Speed

The main BRAILLETRAN program has been designed to be run on an IBM 7040 computer with 16K core storage, character handling instructions, and extended performance instructions, using the standard IBSYS system. At least four tape units plus a card reader are required. With a few modifications, it should be possible to run the program on the other IBM 7000-series computers and on the 709.

The BRAILLETRAN companion program requires an IBM 1401 computer with 4K of core storage and advanced programming features. In addition, an IBM 1402 reader-punch, a 1403 printer, and, if tape input is used, one 729 or 7330 tape unit are required.

Because of a lack of sufficient input, translation speed has not yet been measured. However, on the 7040 the speed is estimated to be about 5,000 words per minute, with the companion program producing 100 pages of braille in about 16 minutes.

Implementation

BRAILLETRAN has just recently become operational and, as such, most of the operation of the system has been for developmental purposes. Not much material has been translated yet, and the system has not been tested in production. Final development work is still being done.

The BLNSYS Program

The BLNSYS program is essentially a Grade 1 braille translation program. It was developed at the Medical Computing Center of the University of Cincinnati, Cincinnati, Ohio, to enable blind computer programmers to read their cards and printouts. The program is added as a subprogram to the computer program library and produces braille embossed on a regular line printer modified by placing a soft patch of material on the impact platen. Normal operation of the printer is not impaired.

Program Format[18]

Users preparing programs under this system have a variety of options available to them. Although they are mainly of value in programming, two of particular interest are listed here.

1. *Brailler:* The BLNSYS routine performs a character-for-character conversion of alphameric symbols into their braille equivalent using Grade 1 braille. As such, it may be called directly by the user who wishes to produce a braille listing of some input cards, or it may be called automatically by the system to produce a program listing, core dump, and so on. The brailler is basic to the system in that it is called in automatically when printed output is to be produced. A switch must be turned on to prevent translation into braille and retain the original English printout.

2. *Assembly Package:* This set of programs takes a source deck and, depending on the options specified by the user, produces a post list in English or braille and an object deck.

Equipment and Speed

The BLNSYS program was originally written for an IBM 1401 computer and requires 4K of memory with two tape drives. The machine must also be equipped with multiply-divide, extended programming, high-low-equal compare, column binary, and sense switches. The program has now been written for practically all common computers.[19] Since character-to-character translation is extremely fast, all machines for which this Grade 1 braille translation program exists print with maximum printing speed.[20]

Other Computerized Techniques

At present, braille translation programs, especially those producing Grade 2 braille, require large, expensive, general-purpose computers. Investigation into the use of smaller, less expensive machines, including those built especially and solely for braille translation, is underway.

Already, the Royal National Institute for the Blind in England is planning to implement an automated braille translation system using a smaller IBM 1130 computer. However, British Grade 2 braille is not as complex as its American counterpart.[21]

While some small computers, such as the Digital Equipment Corporation's desk-sized PDP-8 ($18,000 for fast [3.0$\mu$ sec] version; $10,000 for slow [36$\mu$ sec] version) have been used at MIT for translating into braille the output of the large Project MAC computer and other inputs, the unit does not produce complete Grade 2 braille. Because of its limited capacity, the Grade 2 complexity cannot be totally accommodated so that a grade between 1 and 2 is produced.

Computing Machinery

Not all computers can be used to run all programs. For braille translation the machine must have a sufficient capacity to store the many instructions required by the translation programs. Also, the machine must have sufficient speed to process the program within a reasonable and economical amount of time because computer service costs are usually figured by the amount of computing time used. There is thus a tradeoff between computer size and costs.

Often it may be practical to divide a program between two machines. BRAILLETRAN, for example, does this, using the large IBM 7040 for translation and the smaller 1401 for output. Also, it may be possible to use a smaller machine by dividing large programs, such as DOTSYS, into subprogram segments, and sequentially running the segments in successive passes through the computer. Again, a size-time-cost analysis must be made.

It should be noted that even machines of the same size or type may not be able to be used interchangeably with a given program because the programs may be written in a form particular to a special class of machines or the program may require special features not found in other computers.

Costs[22]

Computing equipment is expensive, and the large computers presently needed to accommodate the Grade 2 translation programs are extremely expensive. Computing systems may be bought outright or rented, and computing services are available on a time-fee basis from computing service bureaus.

Computer time may be purchased on medium and large computers at rates of around 50 to 550 dollars per hour. The purchase price or rent of a particular system depends upon the system configuration, the memory size, the number of tape transports, and the number of special features. Exhibit 5.13 lists average equipment costs for a few of the available large and medium-size computer systems applicable to braille translation, while Exhibit 5.14 lists some costs for representative peripheral equipment.

For any data-processing system the cost of the computer is only a fraction of the total cost to the user. The cost of installing and running a computer seems to range from two to five times the cost of the equipment, regardless of the computer model, the type of use, and whether the equipment is purchased or leased. Relatively large fixed costs (site preparation and installation, training, initial programming, file conversion, and so forth) and recurring costs (operating costs, programming and maintenance of facilities) face any computer installation. The writing and debugging of computer programs are both expensive and time consuming. Exhibit 5.15 gives an indication of size and facilities of a typical large computing center.

Unit	*Prices*[a]			
	Purchase	Lease (per Month)	Service Bureau (per hour running time)	Educational Rate[b] per hour running time)
PDP-8[c]	$ 18,000			
IBM-1401	284,875	$ 6,500	$75	
IBM 360/30		7,500		
IBM 7040		14,000		
IBM 360/65		50,000		$100
IBM 7090	2,880,000	63,000	$550 (first shift) $450 (second shift)	
IBM 7094 II	3,134,500	76,000		$200
IBM 360/75		80,000		

[a] Computer prices depend on system configuration, memory size, the number of tape transports, and the number of special features. Prices listed are average prices for representative systems. Some prices are estimated. Specific rates should be required from manufacturer or service bureau.

[b] Prices for users and colleges associated with MIT Computation Center.

[c] Digital Equipment Corporation.

Exhibit 5.13. Representative Computing System Costs (Sources: See Reference 23.)

For IBM 7094 Computer

1301—II 2-Disc Storage Array	$3,500 per month
729—II Magnetic Tape Unit	700
729—IV Magnetic Tape Unit	950

For IBM 1401 Computer

1402 Card Read-Punch	$ 550 per month
1403—II Printer	775
1403—III Printer	1,800
1405—2 Disc Storage	1,515
1311 Disc Storage Drive (1st unit)	900

For IBM System 360

240B Magnetic Tape Unit	$1,335 per month
2311 Disc Storage Unit	575
2201 Printer	900
2671 Paper Tape Reader	144
2822 Paper Tape Reader Control	216

Exhibit 5.14. Representative Peripheral Equipment for Computers (Sources: *Office Automation,* New York: OA Business Publications, Inc., 1964; Auerbach Standard EDP Reports.)

Exhibit 5.15. A Typical Large Computing Center

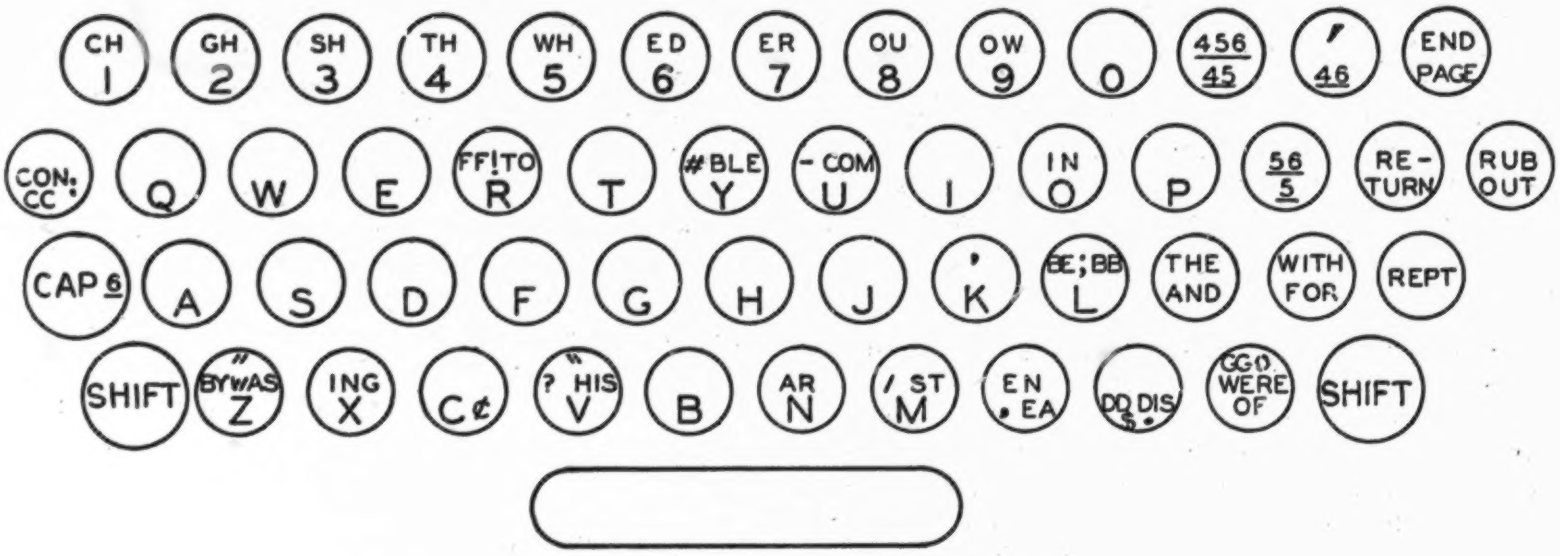


Exhibit 5.16. Tyco-brailler Keyboard (Source: R.W. Woodcock, *Development of an Electromechanical Braille Transscribing and Reproduction System,* Nashville, Tenn.: George Peabody College, 1965.)

Because of their almost prohibitive purchase price and heavy maintenance costs, and because of rapidly occurring improvements in equipment, computers are rarely purchased. Most often they are rented, but even this cost must be justified by a high utilization rate. Where computer-time requirements are small, but extensive facilities are needed, service bureaus are most useful. In fact, it may be economical to do jobs which are able to adequately utilize a small computer on a leased machine, while sending out those requiring short runs on more sophisticated equipment.[23]

New Developments

Computer technology is developing at a very rapid pace, and, indeed, the braille translation systems presently being developed are but first attempts at automated braille production. As with most new techniques, costs will undoubtedly be reduced as refinements are made and experience is gained.

The computers presently being used for braille translation are large, general-purpose data-processing machines. They were not designed specifically for braille translation. It has been mostly the availability of the specific computer rather than its size, speed, or capacity which has dictated for which machine the translation programs are written.

Translation and format flexibility as well as cost reduction probably could be achieved by building a special-purpose machine primarily for translating braille. It is felt that in the next few years a special-purpose Grade 2 braille translation computer utilizing recent advances in rapid, small, and inexpensive computer memory and logic could be built for perhaps $30,000.[24] Looking into the future, it is felt that this cost may reduce to around $10,000 in perhaps five years.[25]

Semiautomated Production Devices

The Tyco-brailler [26]

The Tyco-brailler was developed by Woodcock at the George Peabody College for Teachers in Nashville, Tennessee. It is essentially a modified Teletype Corporation Model 33 teletypewriter unit with a keyboard which contains many of the braille symbols, contractions, and short forms in addition to the standard letters and numerals. The keyboard is shown in Exhibit 5.16.

As described earlier, this system enables an operator to type braille just by depressing the appropriate keys. Although she need not know the actual braille-cell configuration, she still must know the rules of Grade 2 braille in order to produce this grade. While the speed of output of material using this system (in conjunction with an electrified brailler-embosser) is about the same as that of a manual braillist,[27] it has been found in tests that training braillists for this method is approximately twice as fast as training them for manual brailling, while in most cases, error rates are lower using this system.[28]

In addition to providing a specially labeled keyboard, extensive redesigning of certain internal mechanisms was necessary in order to operate the machine in accordance with the braille transmission code rather than the machine code used by the Teletype Corporation in its equipment. A special set of printed characters has been designed to represent the meanings associated with each of the 63 braille cell combinations and a typed copy using these symbols is produced for proofreading purposes. The basic output of these machines is a perforated paper tape, which, in turn, is placed in a paper tape reader to operate an automatic electric brailler. These tapes may also be used to operate stereotyping equipment in printing houses for the blind.

The Tyco-brailler is available from the Teletype Corporation as Model 33TC7571S. Its present cost is approximately $1,600; however, this price may be reduced somewhat if production lots become large enough so that the machines could be assembled on Teletype's production line rather than in their model shop. The unit is in a production-ready state. A similar machine also using teletypewriter equipment has been designed by Mr. R. E. Morrison of the Telephone Pioneers of America, Chicago, Illinois.

The IBM Brailler

Based on the same philosophy as the Tyco-brailler, the IBM brailler is essentially an IBM electric typewriter with a keyboard similar to that of the Tyco-brailler, with the standard type replaced by braille-cell-embossing type, and with a modified platen. This machine, however, types directly on braille paper, producing an embossed copy. The latest model of the machine is still under development, and the price is expected to be in the 400-to-500 dollar range.

The MIT Picture Brailler

A device developed at MIT scans line drawings photoelectrically and produces a dot-embossed version. The device is still experimental, and a very rough estimate places its cost at around 500 dollars.[29]

Distribution Devices

Because almost all of the automated braille production techniques provide output in the form of punched paper tape, punched cards, or magnetic tape, some method of converting this into readable braille or press-braille plates is necessary. In many cases, this must be a two-step procedure. First, the output cards or tapes must be read. The resulting signals are in turn used to drive braille embossing equipment, plate making equipment, or other punching devices. The final product is, of course, embossed braille reading matter.

On the other hand, the output tapes can be used to drive paper-tape punching equipment to produce punched tapes for the tape-to-braille readers mentioned earlier.

In the area of automatic braille embossers for paper, four different types operating at four different output speeds are presently available. The devices along with their speed, cost, accessory equipment, and other characteristics are listed in Exhibit 5.17.

Electrified Perkins Braillewriter[30]

The simplest, least expensive, but slowest of automatic embossers is the Electrified Perkins Braillewriter built by the Howe Press, manufacturer of the manual Perkins Braillewriter. The external appearance of this "electric Perkins" is the same as the manual model except for a small motor mounted on the left side. The weight is increased somewhat by the added parts.

An electric brailler has essentially the same advantages over a manual brailler as an electric typewriter has over a manual typewriter. Furthermore, the electric brailler has provision for electrical keyboards such as the Tyco-brailler keyboard mentioned earlier. The estimated cost of an electric brailler in production would be about 150 dollars.[31] (The manual model costs 90 dollars.)

The problem of providing a low-cost perforated paper-tape reader for the system has received considerable attention. Such a device will allow the use of any paper tape, punched according to the "Recommended Codes for Paper Tape and Card-Controlled Braille Equipment" (Conference on Automatic Data Processing and the Various Braille Codes, Massachusetts Institute of Technology, March 17-18, 1961). Commercially available units that are suitable for this purpose plus the necessary buffering circuits would cost approximately 500 to 600 dollars. A modified Teletype reader has been designed for use with this equipment which would cost about 100 dollars in production.[32]

The tape-driven speed of this embosser is about five to six characters per second. Because the keying action for the brailler is electric so that manual pressure is not needed for embossing, new-configuration keyboards consisting of pushbuttons for keys can be attached to the unit. Special one-hand-operation keyboards are now under development.

The electrified Perkins is presently being tested and evaluated. If performance is satisfactory and demand warrants, the brailler will be put into production.

The Teletype Embosser[33]

Using teletypewriter components as a basis, the Teletype Corporation has developed a braille embosser capable of producing 60 words per minute. The unit, which has a modified keyboard similar to the Tyco-brailler, has the type carrier replaced with embossing heads. The unit thus embosses braille directly. In addition, paper tape can be prepared. The Teletype embosser can also be driven by punched paper-tape input, and it has its own tape reader.

Although considerable development is still needed, it is felt that the embosser could be relatively easily adapted for production because it uses many existing teletypewriter components. Also, most servicing could be carried out by those familiar with teletypewriter units.

Because of its 60-word-per-minute speed, the unit can use standard TWX lines. It operates reliably and provides reasonable, efficient line transmission when online operation is required. The unit is presently in the developmental stage, and a rough estimate indicates a prototype cost of about $1,500 per unit.

Electrified Perkins Braillewriter

Status	Production prototype
Cost	$150
Speed	21 braille pages per hour (5 to 6 characters per second)
Input	Direct, punched tape
Accessories	Punched tape reader—modified teletype reader, $100; Push button keyboard
Comments	Based on standard braillewriter

Teletype Embosser

Status	Experimental prototype
Cost	$1,500
Speed	20 braille pages per hour (60 words per minute)
Input	Direct, punched tape, data line
Comments	Based on standard teletypewriter Engineering development still needed

MIT High-Speed Embosser

Status	Experimental prototype
Cost	$7,000
Speed	62 braille pages per hour (16 characters per second)
Input	Direct, punched tape, computer, data line
Accessories	Console stand; push button keyboard; paper-tape reader (Friden SP-2, $705; Invac P-135, $725)
Comments	Engineering development still needed; may be able to emboss zinc press plates

Honeywell 222 Braille Printer

Status	Available
Cost	Complete system with computer Rental $4,500 per month Purchase $200,000 plus $1,000 per month maintenance Printer only Rental $840 per month Purchase $38,000 plus $320 per month maintenance Off-line Tape Drive System Rental $350 per month Purchase $15,000 plus $50 per month maintenance
Speed	1,020 braille pages per hour (420 lines per minute)
Input	Computer, tape drive, data line (data grade)

Paper for above: About $.0025 per sheet (70 lb. Kraft paper, 2,000 lb. lots)

Exhibit 5.17. Automatic Braille Embossers for Paper Equipment (Sources: Equipment—see text; paper—Carter, Rice, Storrs, and Bennet, Inc., Boston.)

The MIT High-Speed Braille Embosser

The Engineering Projects Laboratory at MIT has developed a high-speed braille embosser. This relatively sophisticated device is capable of embossing about 16 characters per second. Because the embossing heads are carried on an endless belt so that a head is over the paper at all times, no carriage return is needed, and the embosser can perform continuously. As such, it is capable of being driven directly from computer output, from a paper or magnetic tape reader, from an encoded typewriter, or from a braille keyboard. The unit can be connected via regular TWX lines for embossing up to ten characters per second. However, at its high embossing rate, regular voice-grade lines must be used.

One of the prototype models, presently being used to provide braille computer printout at Project MAC at MIT, is mounted in a decorative console with a roll of embosser paper in the base. This is shown in Exhibit 5.18.

The few prototype models built are undergoing evaluation. Because of the sophisticated mechanical and electronic design, and because of the model-shop nature of fabrication, it is felt that considerable development would be necessary before a production version of the embosser could be built.[34] However, the unit has operated successfully and verified the efficiency of its design. It is also felt that the unit may be able to emboss zinc press plates. A rough estimate of costs points to a production cost of about $4,000 in lots of fifty.[35]

For remote, off-line applications, a tape reader, probably for punched paper-tape, would be required. These units, costing about $700, are also listed in Exhibit 5.17.

Computer Printer Braille Embossers

With the advent of computerized braille translation came the discovery that the computer line printer could be used to directly emboss a braille printout. Without impairing the normal operation of the printer, readable braille could be produced on regular printout paper simply by placing a soft backing on the printer platen and printing each dot with a period or asterisk. This method produces a braille dot of about 6 to 9 mills (thousandths of an inch) in height which, although it is much less than the standard 18 to 20 mills, is fairly readable. Because printers are standard equipment with any computer and produce anywhere from 150 to 1,300 lines perminute depending on the unit, these provide a rapid, readily available printout for braille copy. On standard computer paper up to five copies can be embossed at once.

A number of manufacturers are developing so-called "dedicated" printers, specially modified units able to produce braille dots of standard height. At present, only a modified Honeywell 222 printer, has been able to perform this feat.[36] Exhibit 5.19 shows a typical highspeed computer printer.

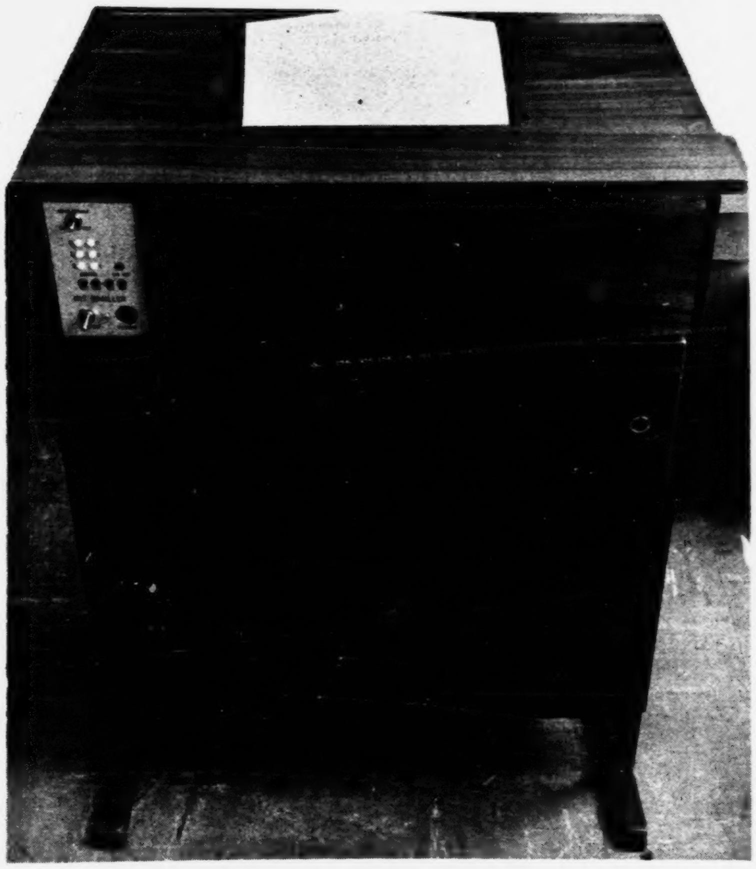


Exhibit 5.18. The MIT High-Speed Brailler Console

The Honeywell 222 Braille Printer[37]

Honeywell has developed a modified version of its Model 222 high-speed printer which in addition to printing Arabic (English) type characters can be easily converted to a unit that will produce braille cells. The mechanics of changing from an Arabic character print to a braille character capability can be accomplished by a printer operator in less than fifteen minutes. The production speed of the printer embosser is about 420 lines of braille per minute. The printer can emboss on paper of weights ranging from standard computer printout paper (13 pound) to standard braille book paper (18 pound).

Honeywell has developed this unit to be used in conjunction with its Honeywell 200 computer with 6K of memory and three tape units. The computer provides for formatting, setting up, and driving the printer. The costs of the complete system and printer components are listed in Exhibit 5.17. Input is from *already translated* braille punched tapes, cards, or magnetic tape.[38]

There is also a possibility that if the translated braille is already properly formatted and compatible with the printer, a simple off-line tape-drive system could be used to drive the printer.[39] This is also covered in Exhibit 5.17. At the high character rate, communication-line transmission to the printer would require at least data-grade phone transmission lines. These are covered in Exhibit 5.11.

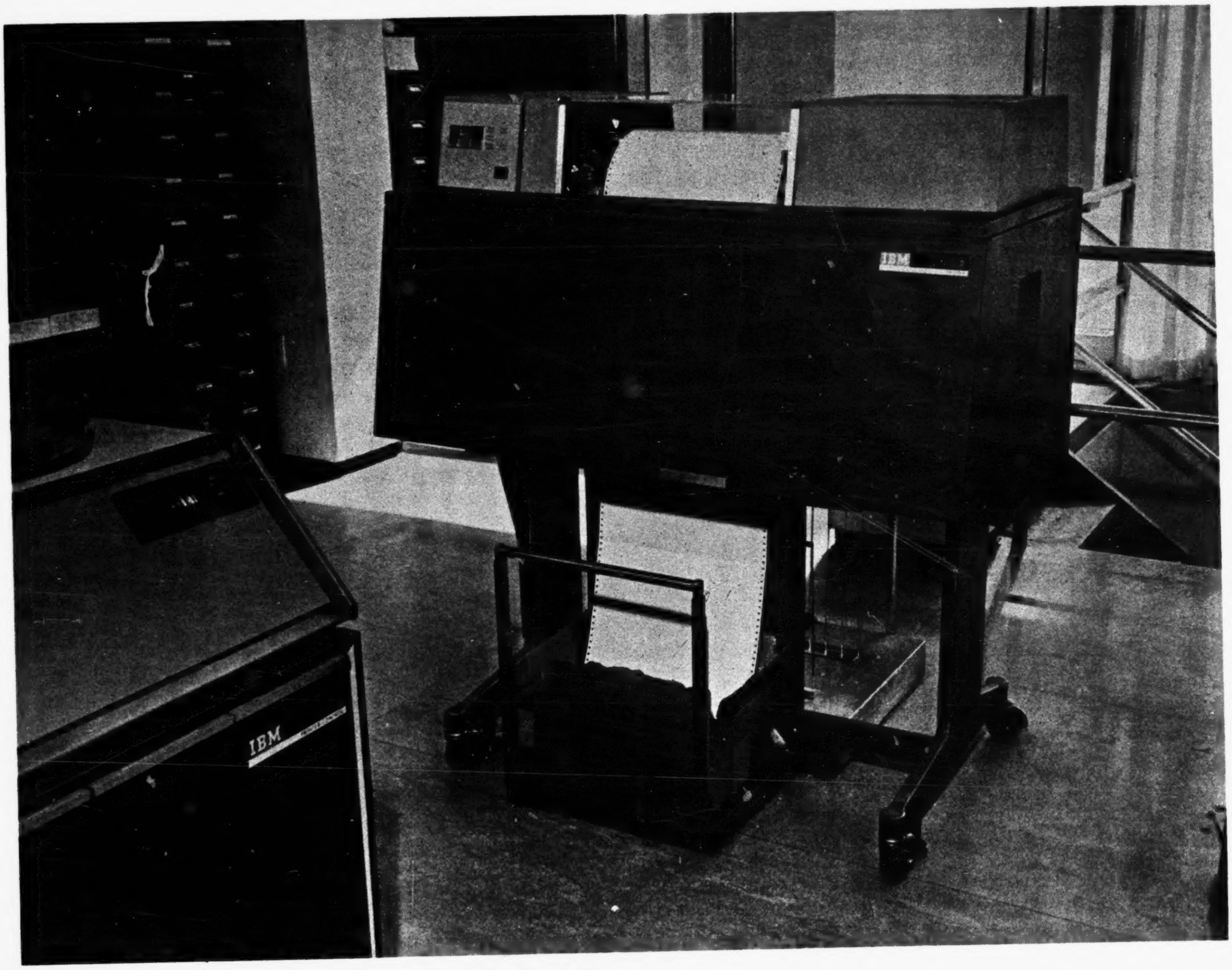


Exhibit 5.19. High-Speed Computer Printer

The standard Model 222 printer is modified at the Honeywell factory with a special conversion kit now costing $9,230. It is conceived that in production quantities, of 100 units, this cost might drop to around 3,000 to 4,000 dollars.[40] The printer is available on a special order basis only.

The Honeywell Braille Printer has been tested in the field and is deemed ready for production use.

Automated Stereographs

Two versions of automated stereographs, a card-driven version and a punched-tape-driven version have been developed by the American Printing House for the Blind and the Howe Press, respectively. These units accept already translated input. These units produce about 80 braille plate pages per day and cost about $10,000. The card-operated ones are presently in production with the APH computerized translation system described earlier.

Tape-to-Braille Displays

The tape-to-braille display units essentially transduce holes in punched tape into braille cells. The idea was initially introduced in a prototype tape-to-braille reader built by IBM, and the project was later undertaken by the MIT Engineering Projects Laboratory.

Exhibit 5.20 shows a prototype of one of the readers using a pin-in-belt principle for reading out the tape code as braille. Similar prototypes using ball bearings as braille-cell elements have also been built. The ultimate aim of these devices is to be able to pass a continuous moving line of braille slowly past the reader's hands. A variable-speed electric-motor drive would move the belt along.

To date, only experimental prototypes of these devices exist. Problems with finding reliable transducer systems and other mechanical problems have created a major slowdown in the development program for these

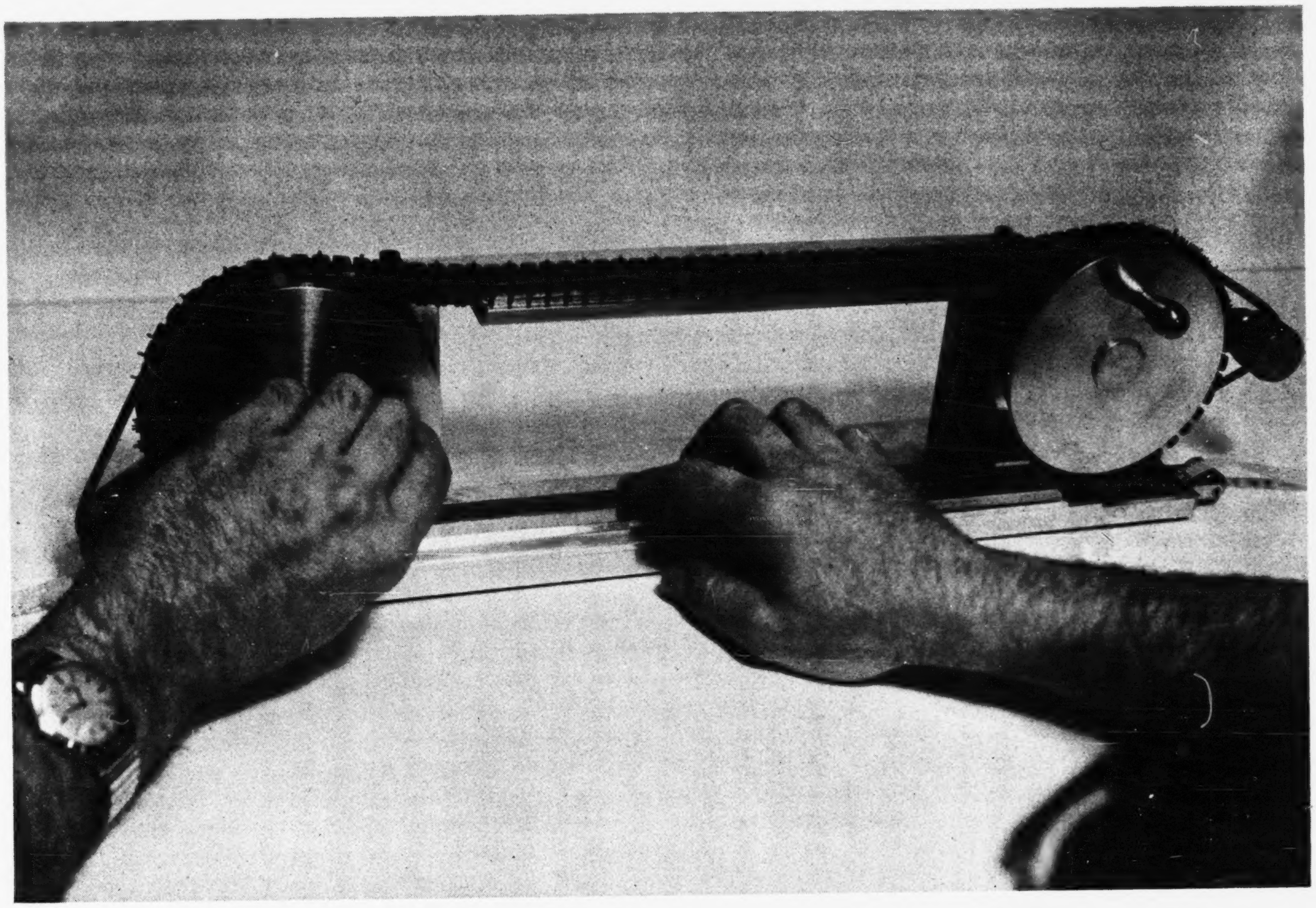


Exhibit 5.20. Line-at-a-time, Pin Element Tape-to-Braille Transducer (Source: *Evaluation Report on... Sensory Aids and Prosthetics,* Cambridge, Mass.: MIT Department of Mechanical Engineering, Report No. 9211-2.)

devices. Also, tapes cannot be press run at present. They would have to be produced individually on a high-speed punch, costing about $465 per month.[41]

Although no cost figures are available for the devices, estimates place the *desired* cost in the 50 to 100 dollar range.

Other Embossing Techniques

Solid-Dot Braille Printing[42]

Traditionally, braille has been produced on stout paper by distorting the fibers to form hollow dots, and, apart from bulk, there is the question of its durability or its ability to withstand repeated reading and handling in transit. The quest for a more permanent braille by the deposition of dots on paper goes back at least forty years, but it has been only recently that technical advances, particularly in the field of plastics, have made possible the development of a practical and economic process.

After many years of trial and error the Royal National Institute for the Blind in England has perfected a method of depositing and heat-sealing solid dots of plastic onto the surface of a thin, strong paper, and, based on this method, a complete processing plant has been designed. The thickness of braille publications so produced is reduced by approximately 45 percent, and, in addition, the dots are uncrushable and do not deteriorate with use. The system, although more costly to install than an embossing plant of similar output, is more rapid and less expensive to operate.

Braille is produced by squeezing soft dots of plastic through a master platen perforated with the desired braille cells onto a web of paper. The dots are hardened on the paper giving the characteristic feel of braille bumps. The process uses 28-pound Kraft paper as opposed to the 80-pound paper used in the normal braille embossing process. This accounts for the reduced bulk of solid-dot braille books.

The zinc perforated stencil masters used in the solid-dot process are made on a special machine. The press now in use produces about 21 sixteen-page sections of braille per minute. This high speed, of course, is useful primarily for large-volume production. However, a smaller-sized unit using the same process could be built.

The economics of the solid-dot process show, as with most production plants, a decrease in unit product cost with increase in quantity output. Examples of the overall cost of magazines as compared to that of embossed publications produced on a rotary machine of similar output rate and in similar quantities are shown below. Costs to the RNIB in 1963 were:

1. 600 copies of a 48-page magazine cost $47.64 per embossed copy against $44.86 per solid dot copy, a saving of 4.5 percent.
2. 2,500 copies of 48 pages cost $33.62 per embossed copy against $28.08 in solid dot, a saving of 11.5 percent.

Further economies in solid dot will result when the process is in full production which will permit the more economic deployment of labor and higher bulk purchases of raw materials.

It is to be noted that due to the greater margin requirements of the solid-dot printing machine, the page areas of magazines are slightly larger than those embossed, and advantage has been taken of this to include 7 percent more braille matter per page.

The RNIB produces embossed books on hand-fed platen presses each of which averages an output of 400 four-page forms per hour. Comparing the complete processes of transcribing, printing, and binding, an overall output advantage for solid dot is shown above 18 copies. Examples of these anticipated savings are 28 percent for 40 copies and 38 percent for 80 copies which include radical labor economies in collation and binding of at least 30 percent when handling 16-page multiples.

It is not possible to give precise guidance as to the cost of a solid-dot installation without considering this in relation to a particular production program. However, the cost of the RNIB solid-dot plant in England in 1963, which included stitching and binding equipment, was about $100,000. The solid-dot press accounted for almost $62,000 of this, while the stencil transcribing and correcting machinery cost about $19,000.

These machines are, of course, designed for the particular needs of the RNIB, but the principles involved with solid-dot printing are, within certain limitations, sufficiently flexible to suit the needs of greater or lesser production than the existing plant. The printing machine, the ancillary plant for producing the stencils, and the subsequent machinery for converting the printed sections into magazines or books have been proved technically sound and with the exception of the process of transcription, where a specialized knowledge of braille is necessary, no highly skilled operators are required due to the foolproofing and safety measures incorporated.

RNIB has expanded its solid-dot production to include a majority of high-volume publications presently produced by rotary or flat-bed presses. Publications not planned for inclusion in the process are leaflets and pamphlets that cannot economically be expanded into 16 pages, and certain specialized textbooks for which the small quantity required, sometimes only one copy, would be quite uneconomical to produce in this way. It is, however, of interest to note that due to the reduction in bulk a production economy measure is possible; the limitation imposed by storage space enables greater quantities of solid-dot books to be held in stock in the same space with a corresponding reduction in the frequency of reprints.

The early assumption that solid-dot braille would be better for the blind reader because the dots are far less destructible and therefore more consistent and easier to read has been confirmed by the majority of opinions received. The added factor of reduced bulk that has been found possible, coupled with the findings that the process is comparable in production cost with that of a long-established process, must be counted as distinct advantages.

Certain principles of the printing mechanism are the subject of an international patent taken out to safeguard the interests of RNIB. Nevertheless, a royality-free license will be available for those using the process. Manufacturing rights for the printing machine are granted to a British company, but the RNIB will be pleased to obtain up-to-date information on plant costs and to place at the disposal of any interested organization the benefits of its experience with the process and to advise on its application to a particular production program. A similar system has been developed by the Japanese.[43]

While solid-dot braille has found very good acceptance among British readers, it has found very little acceptance in the United States. American braille readers seem to have objection to it.[44]

The Multigraph Braille Duplicator[45]

The Multigraph Braille Duplicator, produced by the Addressograph-Multigraph Corporation of Cleveland, Ohio, is essentially a small braille printing press for short runs. This machine is available in three sheet sizes: 8 inches by 8¾ inches; 11 inches by 16 inches; 13 inches by 17 inches. The prices range from $345 for the smallest size to $1,375 for the largest. The machine is normally furnished for hand operation, but it should be possible to fit it up with a motor drive with a minimum of time and cost.

In operation, paper is fed between two drums, one of which carries the braille characters, while the other is covered with a rubber blanket. This operation is very much like that of an offset press. The drum is a conventional Multigraph drum with "T" slots for locating and holding the type in place. Each braille character is made on a standard slug with a key which fits in the "T" slot, locating the characters with correct character and line spacing.

The 64 braille slugs are stored much in the manner of a conventional type drawer. However, slugs containing most two-cell braille contractions are also available. The cost of type is $1.25 for 25 pieces of each character, or an assortment of 1,600 pieces can be purchased for $75. The quality of braille produced with the duplicator is very good, but it premits only one-sided printing.

The time required for embossing is relatively small, and the cost per page is determined largely by the time spent setting and distributing the type. This is roughly equivalent to normal inkprint composition time. The machine was designed to emboss Hammermill braille paper, but any other good braille paper can be used. With the machine sizes available, only single sheets of 11 by 11½ inches can be embossed; therefore, single sheet bindery processes must be used. Because the type and segments are expensive, setups are not normally stored for future use, but taken apart at the end of each run.

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Chapter 6

The Effects of Innovation on Braille Production

The organizations involved in the braille production and distribution system are production-oriented service organizations. Thus, although they do have a nonprofit, volunteer, or charitable nature, the same two major criteria that govern the activities of other production and service industries should govern these organizations also. These criteria are good service and economical operation.

THE ECONOMICS OF AUTOMATED BRAILLE PRODUCTION

In the case of braille production, good service can be measured in terms of availability of material, quality of material, and time necessary for readers to obtain desired material. Economical operation can be measured not only in terms of dollars, but also in terms of efficient utilization of personnel and equipment.

There is a definite tradeoff between economics and service, and the decisions to be made are not always easy. The availability of automated production processes now complicates the decision even further so that careful consideration must be given to the alternatives involved. Is it better to have readers wait two months for a complete copy of a textbook produced by a volunteer for $3.00 or to have them wait only two weeks but pay $50.00 for a computer-translated version? Is it better for each group to duplicate a book separately in four hours on a $450 machine at a material cost of four cents per page or for all groups to use a central facility requiring half-an-hour on a $45,000 machine at a material cost of one-quarter of a cent per page? These are the types of questions that must be answered. The answers, of course, depend on a study of the production circumstances and reader requirements.

Another factor to consider is just how rapidly the brailled material is really needed. Reducing request time from months to a month or to weeks may be easily feasible, whereas reducing the time to days, a feat which is technologically possible but much more expensive, may not really be necessary.

Backlog and shipping times must also be considered. To have an item wait for a week to be processed in one hour does not take full advantage of the one-hour processing time. Transit times also enter here. Material for the blind, although it is posted free, travels fourth-class mail. Thus, two weeks could easily be required for material shipped over long distances. These factors must be taken into account in planning an overall strategy.

For purposes of analysis, the areas for consideration can be divided as follows: single requests, press braille, distribution. While a thorough analysis of all considerations in these areas is a job of great magnitude and beyond the scope of this book, each area will be considered briefly.

Single Requests

The single request is now normally handled by a braillist group and is assigned to a volunteer to fulfill. Requests usually arise for the following items: textbooks, recreational reading, educational materials, professional and occupational material, personal material, duplications. Because most services of volunteer groups are free or, at most, just cover costs, low cost is a very important factor here. Groups have very little money for capital equipment, and it is unlikely that much money could be raised by any one group, even with a governmental subsidy, if such a program were to come about. On the other hand, the possibility of central equipment for a local area or, under certain circumstances, for a regional or even national area does exist. Facility usage will depend on the type of material desired and the source material available.

Textbooks and Recreational Reading

Textbooks and recreational reading material comprise the great majority of single-copy braille-book requests. The most significant factor affecting the choice of production schemes involves the availability of compositor's media inputs. Depending on the publisher and the age of the book, these may or may not exist; media for books are discarded soon after publication. Similarly, certain formats, such as complex mathematics or texts with many symbols, are presently not translatable by computer. Exhibit 6.1 shows the costs of single-copy book production by various methods. In cases where automated production is used, it is assumed that the braillist group will own the preparation machinery, whereas computer time and other expensive services will be provided by a service bureau.

From Exhibit 6.1 a few conclusions can be drawn about the present state of affairs. As can be expected, cost goes up with the amount of work relegated to the machine. At first glance it appears that brailling time could be cut in half for not too much more expense per book by using a semiautomatic brailler. This presumes, however, that the operator is both a typist and a braillist, and that using the semiautomatic embosser is, indeed, twice as fast as manual brailling. It may be possible, however, for an expert braillist to perform as fast using a simple manual braillewriter as an ordinary braillist would using the machine.

Perhaps a group might acquire one semiautomatic machine for use on very high priority jobs. However, the machine could, at most, handle two books in place of one, and it would probably be constantly occupied. Recruiting only one more volunteer braillist could probably increase production capacity by the same amount as a machine.

At the present state of computerized-translation technology, the predominant circumstances under which a group could use a computer to translate a book would be if compositor's media were available. This

Standard Manual Embossing (2 months, $10)

Time[a]	150 man-hours (2 months)
Cost	$10.00, for materials only
Machinery	Braillewriter, $90 (owned by volunteer)
Personnel	Skilled Braillist

Semiautomatic Embosser (1 month, $17)

Time	75 man-hours (1 month)
Cost	$10.00 for materials; $7.00 for depreciation[b] and maintenance
Machinery	Teletypewriter Brailler, $1,500
Personnel	Braillist-typist

Typed-Input Computer Translation (1 month, $117)

Time	75 man hours	75 man-hours (1 month)
	.5 read-in hours	plus 2 machine hours[c]
	.25 translation hours	(2 days including transit)
	.5 read-out hours	
Cost	Materials—$2.50; translation—service bureau, $100, educational, $50; depreciation and maintenance—$16	
Machinery	Tape-preparation machine: $3500	
Personnel	Typist	

Media-Input Computer Translation (2 weeks, $113)

Media Obtaining[d]	2 weeks	
Time	2.5 read-in hours	
	.25 translation hours	5 machine hours
	.5 read-out hours[e]	
Cost	Materials—$2.50; translation—service bureau, $100, educational, $50; incidental—$10	

Optical-Reader Computer Translation (2 days, $360)

Time	1.6 read-in hours	
	.25 translation hours	4 machine hours
	.5 read-out hours	(2 days)
Cost	Materials $2.50 Reading: Service Bureau $250 Translation: Service Bureau $100	

[a] Based on 300 inkprint pages or 600 braille pages per book.
[b] 5-hr. day, 260 working days for 10 years.
[c] Includes manipulation and transfers.
[d] High-speed line-printer embosser.
[e] Assumes availability and usability of compositor's media and mailing time from publisher.

Exhibit 6.1. Single-Copy Braille Production Methods for Books (Sources: See text, Chapter 5.)

Standard Manual Embossing ($.60; 12 minutes plus transit)

Time	12 minutes per braille page plus transit time
Cost	Volunteer—negligible material cost
	Paid—$.60 per page[a]
Machine	Braillewriter
Personnel	Skilled braillist

Semiautomatic Embosser ($.40; 7 minutes plus transit)

Time	7 minutes per braille page plus transit time
Cost[b]	Volunteer—3 cents per page depreciation
Paid	Paid—$.37 per page plus $.03 depreciation
Machine	Teletypewriter brailler, $1,500
Personnel	Braillist-typist

Direct-Input Computer Translation ($.35; 4 minutes plus transit)

Time	4 minutes per braille page plus transit time
Cost	TWX—$.10 per braille page
	Embosser (teletype)—$.03 per page (depreciation)
	Translation—Service Bureau $.02 per page
	Educational $.01 per page
	Paid personnel—$.20 per page

[a] Based on $3.00 per hour salary.

[b] Based on 20-page average per work day, 10-year machine life.

Exhibit 6.2. Single-Copy Braille Production Methods for Brief Material

would require that (*1*) compositor's media for the book exist, (*2*) it is machine readable and translatable, (*3*) the media could be obtained in a reasonable amount of time, and (*4*) the cost would be acceptable to the group or to the reader.

Perhaps in the future a central or regional computer might be available either at economical rates or with subsidy which would make this method more feasible. Groups could send their very high priority machine-translatable work there while doing other jobs or specialty requests manually. However, much input would probably have to be done via optical reader because input media are not always available. If they were, some method of expediting delivery would be required for prompt production.

Educational, Occupational, and Personal Material

Another area in which single requests are prevalent and rapid transcription is desirable is that of educational, occupational, and personal material. A school may need a handout or a test brailled, a professional may want a braille reference copy of a journal article, or a reader may desire a permanent braille copy of a letter. It is assumed that for various reasons the requester prefers braille to audio presentation in these cases.

Here, the circumstances are somewhat different, because works are usually short and rapid reproduction is desired. Because of the nonstandard inkprint forms of these requests and their brevity, no major effort would be needed to recopy the material for transcription, and direct typing would probably be easiest. Exhibit 6.2 lists some of the alternatives for producing such material.

In this exhibit two cost figures are given. One is for volunteers, essentially eliminating the labor cost. This would occur if a braillist group or a volunteer were to perform the transcription duties. The other is for paid personnel to operate the machines. This may occur, for example, in a school system in which there are a number of blind students and there is either a central transcription terminal or a terminal in each school.

Two factors should be noted. First, labor costs are a major factor, and, while there does appear to be a difference in the per-page costs with the various methods, costs are very sensitive to the assumptions made. Figures here are intended as guides only. Second, production times are not critical. Transit times—transporting the material to and from the transcription center or group—will be the governing time factor.

Duplicating procedures will be covered later.

Standard Stereograph Embosser (13 days, $1,080)[e]

Time[a]	100 man hours (13 days)
Cost[b]	$1,080 ($1.80 per plate page)
Machinery	Stereotyper, $4,000
Personnel	Skilled braillist

Semiautomatic Embosser (12 days, $770)[e]

Time	75 man hours (9 days)
	8 stereograph days (3 days)
Cost	Typing—$600[c]
	Stereograph tending—$100[c]
	Depreciation and maintenance—$70
Machinery	Tape-preparation machine—$3,500
	Automatic stereograph—$10,000
Personnel	Braillist-typist
	Stereograph operator

Punched-Card-Input Computer Translation (16 days, $1080)[e]

Time[a]	100 man hours (13 days)
	8 stereograph days (3 days)
Cost[b]	$1,080 ($1.80 per plate page)
Machinery	APH computerized translation system
Personnel	Keypuncher
	Computer operator

Typed-Input Computer Translation (12 days, $670)[e]

Time[a]	75 man hours (9 days)
	.5 read-in hours
	.25 translation hours 1 machine hour[d]
	.5 read-out hours
	8 stereograph days (3 days)
Cost	Typing—$400[c]
	Translation—service bureau, $100; educational, $50
	Stereograph tending—$100[e]
	Depreciation and maintenance—$70
Machinery	Tape-preparation machine—$3,500
	Automatic stereograph—$10,000
Personnel	Typist
	Stereograph operator

[a] Based on 300-inkprint pages or 600 braille pages.
[b] APH figures.
[c] Includes estimated overhead on labor.
[d] Includes manipulation and transfers.
[e] Cost does not include $120 for press-plate material ($.20 per plate.)

Exhibit 6.3. Press-Braille Plate Production (Sources: See text, Chapter 5.)

Exhibit 6.3. Press-Braille Plate Production (continued)

Media-Input Computer Translation (4 days, $250)

Time[a]	2.5 read-in hours	
	.25 translation hours	5 machine hours[d] (1 day)
	.5 read-out hours	
	8 stereograph days	(3 days)
Cost	Translation—service bureau, $100; educational, $50	
	Stereograph tending—$100[c]	
	Depreciation and maintenance—$50	
Personnel	Stereograph operator	

Optical-Reader Computer Translation (4 days, $500)

Time[a]	1.6 read-in hours	
	.25 translation hours	4 machine hours[d] (1 day)
	8 stereograph days	(3 days)
Cost	Reading—service bureau, $250; lease, $175	
	Translation—service bureau, $100; educational, $50	
	Stereograph tending—$100[b]	
	Depreciation and maintenance—$50	
Machinery	Automatic stereograph—$10,000	
	(Optical reader—$15,000 per month)	
Personnel	Stereograph operator	
	(Optical reader operator)	

Press Braille

Automated braille translation appears to be of great value for press braille, especially where input media are available. Exhibit 6.3 lists alternatives for the production of press-braille plates. As shown, the use of the computer may cut transcription costs in half even if the book must be retyped. If media or optical inputs are used, costs can be cut even further. Note that manual labor accounts for both the greatest time factor and the greatest cost factor. In addition to cost and time reductions, the production capability of braille presses for books for the blind will be greatly increased.

Equipment Considerations

Careful study is necessary to determine how computer translation can best be exploited. The type of installation used will depend on the prices and type of equipment and on the scale of production.

Equipment such as the typical IBM 7094 computer presently rents for approximately $76,000 per month. This would require a production of over 760 books per month in braille before service bureau rates could be improved upon. When one considers that the yearly press-braille production is fewer than 760 titles, the importance of economic considerations becomes more obvious. At the present rate of 80 titles per month, or even raising it to 100 titles, only a $10,000 a month machine would be economical if all press-braille production were done on it. (The typical IBM 1401 rents for $6,500 a month.)

On the other hand, because of the availability of service bureaus in many parts of the country, both large and small braille publishers can take advantage of computer translation. Replacing manual stereotyping equipment with automatic equipment (presently about $5,000 for each conversion procedure) would be the only change necessary. The whole process, however, depends on the availability of suitable input media and devices.

Book Selection Considerations

A number of considerations arise when one contemplates large-scale use of computerized braille translation. The first involves selection of books. Because compositor's media are usually discarded as soon as print galleys for books are made, and because it is unlikely that publishers would wish to commit space to storing the media, braille transcribers will have to obtain these tapes immediately upon their release. This will require either a definite plan as to which books are to be published in press braille and a request for their media as soon as the inkprint editions appear, or, perhaps, a central clearing warehouse for compositor's tapes to which all tapes of interest would be sent. If the books were to be on standard teletypesetter tape, occupying about half a cubic foot per book,[1] storage costs in space alone could amount to an average of 25 cents per month per book.[2] Four-inch wide monotape would increase this to about $1.00 per month per book.

An alternative to this might be to immediately translate books of interest, taking the chance that they would be translated eventually anyhow, and storing them on magnetic tape at about one-hundredth of a cubic foot per book.[3] Storage costs would then average less than 0.5 cents per month per book.

Using an optical reader for all books, while alleviating the problem of media or magnetic tape storage, would be a rather expensive solution to book input if compositor's media were available.

Administrative Considerations

If service bureaus were to be used for computerized translation, no extensive reorganization of production would be required. Each producer could continue producing books as before, utilizing the service bureau as he wished. Granting of special rates or direct subsidy would make this even more lucrative.

On the other hand, the lease or purchase of a computer, be it general purpose or specially built, standard rate or subsidized, would benefit greatly from a high utilization rate by lower costs. At present, though, even the press-braille output of the four large braille presses is inadequate to utilize a large machine fully. Thus, some pooling arrangement might be necessary.

Here, too, there must be careful study. Considering capacity alone, one large computer could probably produce all the output necessary and benefit from production economies. However, the processing time required by administrative procedures for such a center, and the delays caused by order backlogs, would also have to be considered. If these were to become serious, the time used up this way plus the transit time required for fourth-class mail could eradicate all the benefits of rapid translation time.

Inventory Storage

The ability to store books on punched or magnetic tape may offer some economical, space-saving, inventory-reducing solutions to the inventory storage problem. At present, braille presses have two forms of inventory: press plates and finished books. The press plates are stored for as long as the books are kept in print to facilitate making another press run should demand warrant it.[4] Finished inventory, of course, is kept for distribution-from-stock purposes. Because the economics of press runs are such that thirty copies is about the minimum number that can be economically embossed, these copies must often remain in storage for years.

Storing an average book costs about 37 cents per book per month. Storing the press plates for this book costs about 95 cents per book per month. It may thus be worthwhile to consider discarding plates and storing the translations in the form of punched tape or magnetic tape. New plates could then be made if another press run were necessary. Economic considerations for this are shown in Exhibit 6.4.

Similarly, consideration might also be given to producing very little over the minimum press run for books of low demand, and after the initial stock runs out, embossing a single copy when an order is received. This is also shown in Exhibit 6.4. While more accurate figures would be needed before a final decision could be made, the indication is that storage inventories could be cut considerably with this system. Indeed, for some books, press runs may not be needed at all.

Distribution

No matter how effective or how rapid production processes may be, the material produced is not of use until it is in the hands of the reader. For this reason, efficient distribution is as necessary as efficient production.

Transit Considerations

Material for the blind is usually sent free of charge via fourth-class mail (parcel post). Transit times by this method can sometimes be quite long. Under normal circumstances a delay of an extra week is usually not critical because production or procurement times are long anyhow. Even when production is rapid, and the major delay then becomes transit time, reducing procurement time from two months to two weeks is still a significant milestone.

If reductions in transit time are desired, other modes of transmittal are available. There are, in addition to surface parcel post: air parcel post; first class mail; direct wire. Exhibit 6.5 lists relative costs and transit times for the various modes and for books in various forms. The mail services, of course, allow material to be sent directly to the user. Because it is unlikely that the average braille reader would have communication-terminal equipment in his home, it is possible that direct wire transmission would have to be via an intermediate point—either a braillist group, service bureau, or braille publisher. This would again involve standard mail service between the intermediate point and the reader.

Direct-wire transmission also requires receiving equipment and embossing or punching equipment, both discussed in Chapter 5. Here, too, volume of production would have to justify this equipment.

STORAGE COSTS

Medium[a]	*Storage Space* (cu. ft.)	*Storage Costs*[b] (per month)
Press braille plates	1.90	$.95
Finished inventory	.75	.37
Punched tape	.50	.25
Magnetic tape	.01	.005

REPRODUCTION COSTS

Method		*Cost*	*Equipmentation*
Punched-tape to plate		$100[h]	Automatic stereograph
Magnetic tape to plate		$125[d,h]	Automatic stereograph[d]
Punched tape to single copy		$ 4.00[c,e]	MIT Embosser
Magnetic tape to single copy		$ 5.75[f]	Honeywell Embosser and Tape Drive
Thermoform Duplication	Material	$ 24.00	Thermoform Machine
	Labor	$ 20.00	
Punched tape duplications	Equipment	$ 9.00[g]	High-speed (150 cps) tape punch
	Material	$ 6.00	

[a] Interpointed book, 3 voulmes.

[b] Based on $5 per month per square foot overhead, 10-foot ceilings.

[c] Includes overhead on labor.

[d] Assumes tapes sent to service bureau for conversion to paper tape, and paper tapes run on stereograph.

[e] Books per working day, 10-year equipment life.

[f] Equipment rented, 20 books per working day.

[g] Equipment rented, 7 books per working day.

[h] Does not include $120 plate material cost ($.20 per plate). Plates can be sold for reprocessing.

Exhibit 6.4. Braille Storage and Reproduction Costs

Library Services

The braille libraries, be they branches of the Library of Congress, school depositories, or organization collections, perform three main functions: they obtain books, store books, and distribute books. Obtaining books will probably not change drastically in the near future. Braillist volunteers will still produce individual copies, and braille presses, perhaps aided by computers, will produce multiple-copy material, perhaps in slightly changed format.

Like the braille presses mentioned before, libraries, too, have inventory storage problems. Here again the procedures mentioned before may be of aid. In this case, books for normal circulation could be kept in hard-bound copy as they always have been. However, books of low circulation could be stored on punched or magnetic tape and, as shown in Exhibit 6.4, reproduced upon request.

Indeed, it may be possible to reproduce the book on lighter, inexpensive paper and request that the reader dispose of it when he is finished. In this manner, books could be shipped in envelopes rather than packing cases, uninsured. Also, the process of remailing, receiving, and reshelving would be eliminated, reducing clerical costs and time as well as storage space.

With the benefits of compact storage, it might be possible for central depositories to store tapes for all braille books produced. Then, rather than having to locate a copy of a book it does not have or which it does not carry because of space or demand considerations, a regional library could request that a runoff of the book be sent directly to the reader.

Perhaps, where a copy is urgently needed—for example, where the first two chapters of a textbook would serve a student until a copy of the whole book reached him—these chapters could be airmailed. If feasible, the direct-wire facilities of the Federal Telecommunications Systems might be used to transmit these chapters to a service-bureau printer or a branch-library embosser. The possibilities are many, but careful study is needed.

THE MARKET FOR NEW DEVICES

Much consideration and much development still are required before any of the new devices or concepts,

Mode	*Book Form*[a]	*Cost*			*Average Time*	*Remarks*
Fourth-class mail	Any	Free			1-2 weeks	
Air parcel post		Zones 1-3	5	7		
	Standard manual	$ 8.84	$10.30	$13.07	1 week	
	Standard interpoint[b,c]	4.52	5.26	6.59		
	Punched tape	1.64	1.90	2.27		
	Magnetic tape	Send First Class				
First Class		Air		Surface		
	Standard Manual	$23.00		$14.40		
	Standard Interpoint	12.50		7.20	Air, 2 days	
	Punched tape	4.16		2.40	Surface, 4 days	
	Magnetic tape	24		.15		
Direct Wire	Standard phone line (150 characters per second)	New York-Ann Arbor Day—$22.70[d] Night—$13.45			67 minutes plus conversion time	Need Honeywell Embosser or high-speed tape system
	Telex (10 characters per second)	$180			16.7 hours	Can use teletypewriter embosser or standard tape punch

[a] Based on 300-page, inkprint book or 600-page braille version; 600,000 braille characters.

[b] 3 lbs. per standard, hard-bound volume.

[c] Both sides of page brailled, 3 volumes.

[d] Does not include data set or conversion costs.

Exhibit 6.5. Material Transmission Possibilities

especially those still in the prototype stage, can be considered ready for consumer use. There is a great difference between a device that performs "satisfactorily" in the carefully controlled environment of the laboratory under the watchful eye of its developer and one that performs reliably, economically, and efficiently under grueling use for a demanding consumer.

Market demand is not easily determined. What may appear to be a very excited, convinced buyer when a concept is described to him or even an operating prototype is shown to him may become a difficult customer after he prepares an operating budget for the board of directors or finds out that he must alter his operation. Very careful, critical, analytical study is needed before demand can be estimated.

Also, because of the growing amount of research in sensory aids, there are now many devices and techniques available for performing the same task. Some are more suited to certain production capacities, use environments, or budgetary constraints than are others. Some devices have been superseded by more recent devices, and some would require so much engineering development to make them fit for consumer utilization that the cost would become prohibitive. This must all be taken into account.

Characteristics of the Market

As a consumer market, the market for braille is small and the market for associated devices is even smaller. The market segments and approximate size are listed in Exhibit 6.6. While this is an indication of market potential, the actual markets, especially for complex or expensive devices, are much smaller.

Economic considerations are a very important factor. Among those who are active braille users, school children, students, and some of the employed blind can be considered as having an economic status in line with national norms. However, one half to three quarters of the casual readers—the major segment of the market for braille—have below-average incomes. Probably none but extremely inexpensive and very useful devices will be of any appeal to these readers.

Groups and organizations usually have economic problems as it is. Almost all are nonprofit, and most subsist on either donations or local, state, and Federal subsidies or appropriations. Because of this factor, directors usually find it difficult to make large capital expenditures, and they are usually reluctant to make great changes in existing systems without very convincing supporting evidence.

Braille Readers	
School Children	9.900
College Students	1.450
Employed Blind	2.500 [a]
Casual Readers	25.000
Aged Blind	6.000
Deaf Blind	700
Total	45.550
School (programs for the blind)	
Residential	59
Public (systems)	354
Braille Libraries	
Library of Congress	28
Other (varying size)	100 [a]
Braille Producers	
Braillist	6.000
Braillist Groups	280
Large Braille Presses	4
Other Presses and Publishers	17
Service and Other Organizations (sheltered workshops, lighthouses, blind service agencies, etc.)	500 [a]

[a] Primarily a magnitude-indication figure.

Exhibit 6.6. The Braille-Associated Market in the United States (Sources: See preceding chapters.)

The Market for Devices

While it is very difficult to predict market response accurately without considered study of the market, some estimates—at best, order or magnitude figures—can probably be made from the data at hand. These are shown in Exhibit 6.7. Considered along with those organizations directly involved in braille production and distribution are those service bureaus that might, under certain circumstances, acquire special equipment for braille production.

Note, however, that this report discusses only the United States market. A larger market for braille and associated devices outside the United States, which, for the purpose of this report, has not been covered, is equally important.

Input Devices

The potential market for input devices will probably consist primarily of organizations directly concerned with the production of braille. However, the purchase of an input device will probably tie in with a commitment to automated braille production. Thus, because of the complexity and expense involved with the devices, only organizations with high production levels, substantial budgets, and a real gain to be shown from automated braille production will probably be interested in these devices.

As discussed earlier, the major benefit of manual input preparation is that a typist or keypuncher rather than a skilled braillist is needed. However, as shown in Exhibit 6.1, the use of this method or even automated translation in general is not presently advisable for the type of work that braillist groups do. The amount of time saved in brailling does not justify the cost. Recruiting just one more volunteer braillist would produce the same result at no cost. Even *paying* a supplementary braillist about $2.00 an hour would yield the same production for almost the same cost as automated translation, but with no capital investment. Until such time as the cost of automated braille translation is drastically reduced and its capabilities are increased, the single requests for books and specialty works to be done by braillist groups will best be done manually. The major problem will be the availability of braillists.

Braille presses, then, appear to be the ones that will provide the major market for automated translation of long works. Until such time as widespread use of media and optical readers comes about, manual tape and card preparation will still be needed. While costs may even be approximately the same as those of manual production, as shown in Exhibit 6.3, the relief from the need for skilled braillists and, perhaps, a slight reduction in time and costs will still justify this method. It is envisioned however, that only the major braille presses will adopt it.

As media readers become more usable and costs decrease, the smaller presses and publishers may avail themselves of service-bureau facilities, thus causing some service bureaus to invest in added equipment. Similarly, as optical readers are developed for book-type reading, a few service bureaus might be induced into investing in them, perhaps for their general-purpose work as well as for braille production.

For rapid production of short works, direct-input terminals for computers may be lucrative in a few locations where easy access to a time-shared computer is available. Such locations will probably increase in number in the years to come, and costs may decrease with widespread use.

Under such circumstances schools, school systems, residential schools, or even regional pools that have enough of a production requirement to warrant the investment may take advantage of this translation method. Similarly, some braillist groups, perhaps those that serve a number of schools or employed individuals, may also find such a system worthwhile. Also, the beneficial effects of these devices on the learning process of blind students, as mentioned earlier, may increase the education market size even further.

Production Programs and Devices

When braille presses begin to avail themselves of service bureaus, there will probably be a call by these organizations for a braille production program to be used on their equipment. Perhaps ten service bureaus across the country may serve the major braille presses and publishers. (Note that the 21 major presses and publishers are located in only ten areas.)

Because, as stated before, the justification of operating an in-house computer can be found only with very high utilization, and then only if small machines or lower costs become realizable, it is not envisioned that many more than two in-house systems would be warranted.

The semiautomatic embosser, both direct and punched-tape, will probably need more exposure before accurate estimates of its usefulness can be made. Although time estimates here have been based on a 2 to 1 speed factor over a manual brailler, this has not been conclusively proven. Also, the reduction of braillist training time and error, if this actually be the case, must be evaluated as to its real value. If the semiautomatic brailler is shown to have only a small advantage over the manual device, this may not warrant the extra investment. On the other hand, if it does, the combination of direct and on-line embosser embodied in the Teletype embosser may reduce the appeal of the Tycobrailler unit.

The picture brailler is now only an experimental prototype, and extensive use testing has not been done. Because it requires that line drawings be made anyhow, before the unit is used, and because line drawings appear in only a fraction of brailled books, mainly textbooks, the appeal of the machine—which would be of use mainly to braillist groups for individual-copy work—should be carefully analyzed before extensive development is undertaken.

Distribution Devices

As shown in Exhibit 6.4, the distribution devices developed offer great promise in rapid transit times, inexpensive duplication, and inventory reduction.

1. *The Electrified Perkins:* The electrified Perkins Braillewriter, while much too slow for on-line embossing of long works, will probably serve admirably as an inexpensive automatic embosser for short jobs. Probably a 100 to 200 dollar terminal box would be necessary to make the unit compatible with data lines.

The greatest appeal of the electrified Perkins, however, will probably come because of its ease of use; it offers much the same advantage of speed and ease over a manual braillewriter as an electric typewriter does over a manual machine. Many braillists would probably welcome such an item. As a result, sales are estimated to be much in the same proportion to manual braillewriters (about 30,000) as electric to manual typewriter sales. The increase in price (from $90 to $150) is probably warranted by the improvements offered.

2. *The Teletype Embosser:* The Teletype embosser is not estimated here because, while the cost of the embosser is ten times that of the electrified Perkins, the speed is the same. It is true that the Teletype unit also provides for direct embossing via a typewriter-type keyboard, but the efficacy of this, as described in the section on semiautomatic embossers, has not been proven yet. If the semiautomatic embosser is found to have definite advantages, the combination of direct and on-line embosser may find a market in schools and braillist groups.

3. *The MIT Embosser:* The MIT embosser, being intermediate in both expense and speed, may find acceptance in some larger libraries, for short-book, single-copy production from punched tape, and in some braille presses, if indeed the unit can reliably emboss zinc plates. Perhaps lighter zinc plates for shorter runs could be embossed from punched tapes on this unit, relieving the need for a more expensive automatic stereograph unit for heavy-duty zinc plates. A small braille press could then send its material to a service bureau for translation and receive the translation as punched tape.

4. *The Honeywell Printer:* The Honeywell Printer will probably find acceptance where high-volume, single-copy production, perhaps from magnetic tapes, would take place. Central tape-library depositories and large braille presses would probably benefit from the unit. Similarly, some service bureaus involved in braille preparation may wish to acquire a unit for direct, single-copy printout. Because the printer could also be used as normal, general-purpose equipment, a service bureau could probably justify the investment. The service bureau could then offer small presses or libraries the services of the printer for single-copy work where, normally, these groups would not have been able to afford or justify such a device.

5. *Automated Stereographs:* Automated stereographs will find their market in braille presses. The presses will be able to have work translated by a service bureau and then use the output to produce heavy zinc press plates on the automatic stereograph machines.

6. *Tape-to-Braille Displays:* Here, too, no estimate has been made. The advantages originally given for these devices were that the tapes for the displays could be produced on less expensive equipment than could embossed braille, and that bulk would be reduced, and that it would be a personal writing as well as reading instrument. While the first point is true as equipment prices go, the punched-tape equipment costs one third as much as the Honeywell embosser, but has a production rate of only half as much material. Also, punched-tape equipment would probably have a lower utilization rate than embossing equipment due to a lower demand for tape as opposed to embossed books. Thus, the material production cost may actually be higher than that of the embosser.

The reduced-bulk advantage may also not be of as great merit if throwaway embossed material gains acceptance for single-copy circulation, because the bulk reduction between lightweight braille paper and punch tape would be negligible.

Device	*Units*[a]	*Market*
Input Devices		
Tape, card preparation units	10	Braille presses
Media readers	20	Service bureaus, braille presses
Optical readers	4	Service bureaus, braille presses
Direct input	200	Schools, braillist groups
Production Devices		
Production programs	10	Service bureaus
Computer systems (does not include service bureaus)	2	Braille presses
Semiautomatic embosser	--	
Picture brailler	--	
Distribution Devices		
Electrified Perkins	5,000	Braillists, braillists groups, braille readers, schools
Teletype Embosser	?	Schools, braillist groups
MIT Embosser	50	Libraries (braille presses)
Honeywell Printer	10	Braille presses and publishers, central libraries, service bureaus
Automated stereographs	30	Braille presses
Tape-to-braille displays	--	

[a] Does not consider sales for purposes other than use with braille.

Exhibit 6.7. Estimated Market Potentials for New Devices

Last, most blind already own a pocket-sized slate and stylus for short notes and a braillewriter for regular work. These can be used with almost any available type and size of paper, and their output can be easily read without any special devices. Thus, this added output feature on the tape-to-braille unit may not be so great an advantage.

The actual market appeal of tape-to-braille displays must be considered. Unlike the other production methods, this system will require major changes in the present procedures. Either the blind would have to purchase the reading equipment or some sort of massive administrative system similar to the present talking-book-machine distributor and service system would be necessary. There would then be a vicious cycle of having to have a large number of machines in use before the economies of large-scale tape and display-unit production would be realized or before one could use the unit for general correspondence, but needing a large tape-production system before owning a display would become worthwhile.

A whole new approach to reading dynamics with these units would be required of the blind. It is not yet proven that the blind will accept such a change or will even find it of benefit.

With advances that are being made both in standard embossing on lightweight paper and in solid-dot braille production (a 45-percent bulk reduction over standard braille as opposed to 33 percent for punched tape), the great change and investment in a tape-to-braille system may not be warranted. Critical study is necessary.

THE EFFECTS ON THE MARKET FOR BRAILLE[5]

One of the important areas of inquiry as to the aspects of automated braille production is the effect it will have on the market for braille. Authorities in the braille field seem to feel that the actual numbers of braille readers will probably not increase significantly because of the greater availability of braille. Readers read braille because they have to—the materials they need are best read in braille. Under most circumstances, however, recorded material or direct reading is the preferred reading medium because of its ease and speed. Making more braille available would not alter this feeling.

The question, then, is whether the demand among existing readers will increase. This is not easy to answer. Approximately 50 percent of braille readers feel that they are getting fewer books than they would like to, and about 30 percent requested that a wider variety of titles be made available.[6] Yet, braille books in general and press-braille books in particular are produced after careful analyses of demand. Thus, the major type of unfulfilled requests is probably for low-demand material which, at present, would be produced in single-copy form by a braillist group. This type of request, though, cannot now benefit from automated braille production. Until these new methods become capable of economically producing single-copy material, press-braille demand will probably not change drastically. The primary benefits will be the availability of more titles in press braille and lower production costs.

It is interesting to note that about 25 percent of blind readers suggested that, in addition to making more books available, libraries simplify the mechanics of ordering and shipping them and improve the condition of books. This might be done as part of an over-all system improvement.

THE SOCIOLOGICAL EFFECTS OF INNOVATION

The braille production and distribution system does not consist only of money and machines. People are a very important part of it, perhaps more so than in most other production-service systems. As a result, not only must the economic and production effects of innovation be considered but the sociological effects as well.

Social Aspects

While there has been some concern as to the effect that automation would have on the braillist-reader relationship, it is encouraging to note that if there be any change at all it will probably be for the better. The devices being developed will not replace people. Rather, these devices will increase the capabilities of the human element in braille production.

Dedicated braillists will always be needed. Production of single-copy requests, the major portion of braillist work, will not be widely automated. Textual material, special formats, music, and personal material will probably not be economically produced by machine. However, some of the prose work or other book translations which may be available on compositor's media or may be readable by optical input may be feasibly automated if costs can be reduced. Even then, braillist groups will still have to edit, process, and administer production.

What this might do if it does transpire, however, is to free some braillists now doing standard work for doing the speciality jobs and textbook transcriptions for which there is such a demand and for which in some groups a one-to-two-year backlog exists. Indeed, if braille circulation is increased through automation, the demands on braillist groups for special-request work may actually increase.

Braille presses will feel the major effects of automation, and this will be beneficial. Costs will be lowered and production increased. Here, also, braillist-stereotypers will not be eliminated, for there will always be works being produced in press braille for which machine translation is not feasible. The standard works will be taken over by the machine, but braillists will be doing more nonstandard works. Automation will not only increase productivity but also extend the capacities and capabilities of the smaller presses which are now limited by financial or physical constraints.

Political Aspects

Organizations

Automation will probably not foster any great changes in the autonomous structure of the braille production system. Centralization of facilities, with the ensuing problems of control, support, and authority, will probably not take place. Each group will be free, as it has been, to utilize those services it wishes and to produce those works it desires.

This is not to say, however, that improvements in organization or cooperation cannot be made. The greater production capabilities of the organizations will require increased cooperation with coordinating authorities and central catalogs to insure that efforts are not duplicated, that work is being assigned equitably, and that efficient use is being made of the total productive capacity. Because the ultimate goal of braille production is to provide service to blind readers, the whole system, no matter how efficient its machinery is, is only as good as its information and distribution production.

Braille Code

Experts agree that Grade 2 braille is the accepted mode of translation, and all efforts have been made to comply with the rules of Grade 2 in developing translation equipment. To make numerous changes in this standardized system would be unwise.

Nevertheless, there may be opportunities to make some alterations, especially in codes that, while they may have been in common use many years ago, have now nearly passed from use. Whereas bibles and religious works formerly comprised the majority of braille publication, textbooks and business and professional material are now also becoming very common.

A byproduct of the use of computers in braille translation has been the ability to determine the frequency of occurrence of various word, letter, and contraction usage.[7] Studies have shown that certain revisions of the Grade 2 braille code would provide both more efficient symbol usage and easier machine translation.[8] Also, research into totally new embossed codes is being carried out, and these may have much promise when coupled with automated production.

While it is not advisable to alter codes solely so that machine translation may benefit, some alterations may make machine translation much easier, reducing machine size and cost. The Braille Authority, which has the responsibility of developing, clarifying, and interpreting the braille code in the United States, in conjunction with those familiar with machines and machine translation, will have to act on these decisions. This should be begun, however, while the new techniques are still in the process of development.

Opportunities for the Blind

Automated braille translation offers more than just an increased amount of lower-cost reading matter. It also offers an opportunity for people, now restricted not so much by their own initiative as by lack of facilities, to lead more productive, useful, self-fulfilled lives. A blind student with ability in mathematics may be able to greatly increase his potential by the simple addition of a braille-translation computer program to a computing center. This can give him a feeling of self-fulfillment and self-respect that cannot be estimated in dollars and cents.

The opportunity of being able to choose from a wide assortment of current titles in braille can be very beneficial to both the intellectual well-being and the awareness of a blind reader. The availability of articles and reference material for a blind professional is a great help. Finally, the obtainability of textbooks and duplicated material for a blind student pursuing his education in a public school system is invaluable.

These are but a few brief examples of the benefits that can be brought about by the advances in braille production.

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Chapter 7

An Approach to Braille System Development

The Marketing Approach

Despite the nonprofit, volunteer, or charitable nature of braille production and distribution, it is still a production and service industry. The same considerations for efficient management that are applied to industry in general should also be applied to braille production. Similarly, blind readers are consumers and should be treated as such.

The braille production and distribution organizations and the blind service organizations have been performing an outstanding job in trying to serve blind readers. Yet, as with consumer industry, service can always be improved. The new processes and procedures are calling for change, but change and improvement should be made only after careful consideration. Braille must be marketed.

MARKETING

Marketing does not mean simply television commercials, dollar-bingo cards, or cents-off deals. It is a totally integrated approach to offering a quality product, at a reasonable cost, to appeal to as much of the desired market as possible. This involves five areas:

1. *The Market:* Which market is being aimed at? What are its characteristics? Where is it? What types of products does it want, does it need?
2. *The Product:* Does the product fill a demonstrated need? Is quality, quantity sufficient? Is its price right? Will it really perform as desired? Can design or performance be improved?
3. *Production:* Is the product being produced in the most efficient, economical manner? Can this be improved? Can costs be cut?
4. *Information:* Do consumers know of the product? Do they know of the services offered? What can be done to appeal to them, inform them?
5. *Distribution:* Is the product readily available? Is service adequate?

These are by no means simple considerations. However, in an old, traditional industry with well-established processes and policies, change is not simple. The braille industry must now involve itself in new product marketing.

The Market Study

The market for braille is small, and the market for devices even smaller. The market is characterized by diverse needs, limited finances, and social, political, and emotional factors. Procedures have been in use for a century. The time has come for a more comprehensive study of the blind to be made. How many people actually use braille? How many could benefit by it but do not know of the services available? Is there a sufficient market to justify the development of some of the more complex and expensive devices? This information should be known before a product is carried beyond an experimental prototype.

Indeed, one might survey the market to find out what is needed or what changes can be made. Reducing the weight of braille paper from 80-pound to 40-pound stock cuts bulk in half. Maybe punched tape is not even necessary. Do braillists really need a picture brailler, or would redesign of the simple star-wheel or ruler and stylus make picture brailling equally as simple?

The Product

If small, inexpensive microfilm readers were available, would the readers of this report prefer to receive their morning paper on a 1 x 3 inch strip of film? This way, they may avoid the folding, manipulating, and affinity for getting one corner dunked in the morning coffee that comes with the present bulky version of the paper. Would they pay five cents more for this film? Would they buy the reader? Would the newspapers accept the system?

Would the readers of this report prefer reading it a line at a time from a slowly moving belt the size of a reel of recording tape?

These are radical products. So are some of the new braille-producing devices. The situations stated above are essentially inkprint-system versions of the present braille-system situation.

The annals of business are full of histories of new products which, although they may have been technically advanced or may have filled a need, did not survive on the market. Analyses of these cases will usually show that there was insufficient marketing consideration.

It is not easy for a developer or a company which has tried to fill a need, has conceived a product, and has invested heavily in its preliminary development to abandon it. Yet, the losses at this point are much smaller than if the product fails on the market.

In the normal industrial system, a company that has come out with a poor product takes a loss "this time" and makes it up in profits "the next time." The braille industry has no profits that it can afford to lose. It needs all the money it can get, and it cannot afford to let service suffer. The blind need material, and they need the best service possible.

The products of braille research must be evaluated now. Many involve great technological achievements. Many perform feats never before possible. Yet, technological excellence or production abilities are of no value if the product will not be accepted. The final say will be had by the consumers, not by the engineers. Evaluation must come from the braille producer and the blind reader.

Organizations such as the Sensory Aids Research and Development Center at the Massachusetts Institute of Technology can be of great value here by subjecting the concepts and laboratory prototypes to vigorous, unbiased evaluation.

Production

Even if a product be worthwhile, and even if there be a demonstrated market for it, can the product be manufactured and sold for a reasonable cost? Note again that there is a great difference between a device that performs "satisfactorily" in the carefully controlled environment of the laboratory under the watchful eye of its developer and one that performs reliably, economically, and efficiently under grueling use for a demanding consumer. The engineering development needed to make a device producible may be so extensive that the device costs become prohibitive.

Note also that small production runs mean high production costs, and that an interested buyer may quickly lose interest upon presenting his budget request to a board of directors. Studies of production costs should be made in detail as part of the marketing investigation. A rather discouraging but only too accurate rule of thumb is: "Estimate costs and estimate sales, then double the costs and halve the sales."

Information

It is the duty of the producers to tell the consumers what is available. There are probably many blind who do not know of the services available to them. There may be readers who would use more braille if they were more aware of the library services and volunteer help that exist. There are producers who do not know of the extensive research in braille production. These people must be informed.

At present there is a backlog of work for many braillist groups. Technical braille and textbook transcribing is in great demand. In some cases of technical brailling this has resulted in a one-to-two-year delay. At present there are increasing numbers of women educated in technology, the arts, and the professions who have left work to raise families. Still, many would like to do something productive, at home, in their spare time. Some timely advertisements for braillist training in newspapers or alumni and alumnae bulletins may bring a fine response from women whose ability and training make them well-qualified to become braillist trainees.

Distribution

Products that are made must be distributed and serviced. Even for a rather simple device such as the talking-book machine, an extensive distribution and service organization exists. For the complex production devices that have been developed, these services are even more important. Service and distribution costs money, however, and this must be reflected in equipment costs.

Braille books must also be distributed, in this case by libraries. Because of the large amount of mail circulation engaged in by braille libraries, the library operation is often similar to that of an industrial warehouse. The same problems of warehouse location, inventory size and selection, shipping, and receiving are thus experienced by braille libraries.

Perhaps some of the recent advances in modern warehousing and distribution may be applicable to braille libraries.

BRAILLE RESEARCH PHILOSOPHY

The plea for marketing should not be taken so as to discourage research. On the contrary, it should be taken to mean that increased research is necessary to insure that fine products and fine service can be offered at low cost. Development research should produce products, and marketing research should evaluate their potential.

Research Funding

Funds for research are not always easy to obtain. Yet, in a way, they are not funds spent; they are funds invested. In actuality, they are very well invested.

Consider the blind student with mathematical ability mentioned earlier who was able to find employment as a computer programmer. This came about from the simple addition of a braille translation computer program developed through recent braille research to a computing center.

Between 1955 and 1964 over four million dollars were granted for blindness research by the Vocational Rehabilitation Administration.[1] This averages out to about ten dollars per blind American.[2] (In actuality, only a small percentage of this went into research and development of devices to aid the blind.) Through this research, the blind programmer was able to become employed as a professional rather than as a sheltered worker.

If, because of this better opportunity, the earning capacity of this one blind programmer is increased from $5,000 to $10,000 per year, the *increase* in taxes alone paid in only one year—approximately $700—covers more than 70 times the research money spent on his behalf in ten years.[3] This does not include savings in welfare, family aid, and other services which may have been necessary.

Indeed, if the programmer had been a blind student under the government quota funds for blind schoolchildren, his increment in taxes for the one year would more than reimburse the government for its 45-dollar-a-year expenditure during his twelve years of school.

Repeat this example for the many capable blind today, and one can see the benefit of both existing advances in automation of braille production and in the continuing support of research programs in this area.

Commercial Ventures

A number of industrial organizations have expressed interest in entering the market for devices for the blind. Many of the devices of interest have resulted from existing braille research programs. It is very encouraging to see industry moving in this direction.

While there is little doubt that companies will enter the field without proper market study, the interest in aiding the blind should not blur any unfavorable study results. Similarly, such results should not discourage a company from entering the field, perhaps with a different product.

Then too, while the market for braille is small, the market for devices for the legally blind in general is about ten times the size. The company may find it wiser to try and service this whole market.

The market, especially that for braille, should be viewed in terms of a system rather than in terms of a single product. The success of a tape-to-braille display or a semiautomatic embosser, for example, depends not only on initial consumer acceptance of the one device but on developments in the whole field of automated braille production. The tape-to-braille display, especially, would require changes throughout the production and distribution system.

While the government does make funds available for the blind, companies should try to make their projects pay for themselves. The blind are consumers, the blind market is a consumer market, and devices for the blind should be viewed as consumer items. As with consumer items, efforts should be spent on efficient production and cost minimization before subsidy is sought. A well-marketed product should try to meet its costs; government funds are needed for meeting the expenses of basic research and development.

While products should try to meet costs, the size of the market may be such that certain extremely useful devices could never be sold without subsidy. Or, perhaps, a very promising device would be able to meet its production overhead, but no commercial organization can see its way clear to underwrite the development costs. Government subsidy may be necessary here.

Purely economic considerations may overlook the invaluable social, psychological, or educational aspects of a device. Careful study of project funding is thus vitally necessary.

Public Service

Companies interested in public service projects can fulfill a great need by providing production aid or even production facilities for worthwhile products for the blind. Service bureaus may wish to provide braille translation facilities at reduced rates, and reduced rates on communication facilities and data equipment would also be helpful.

The Future

The automated production of braille is still in its infancy. As of this writing (January, 1967), new developments are imminent which will make the production of braille even less expensive and more rapid. These advances will greatly change the estimates, costs, and evaluations given in this report. What is unfeasible today may be commonplace tomorrow.

The immediate goal is for rapid, efficient, economical production of braille. The over-all goal is to make it possible for a blind person to have as many opportunities for personal and professional development as he possible can.

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